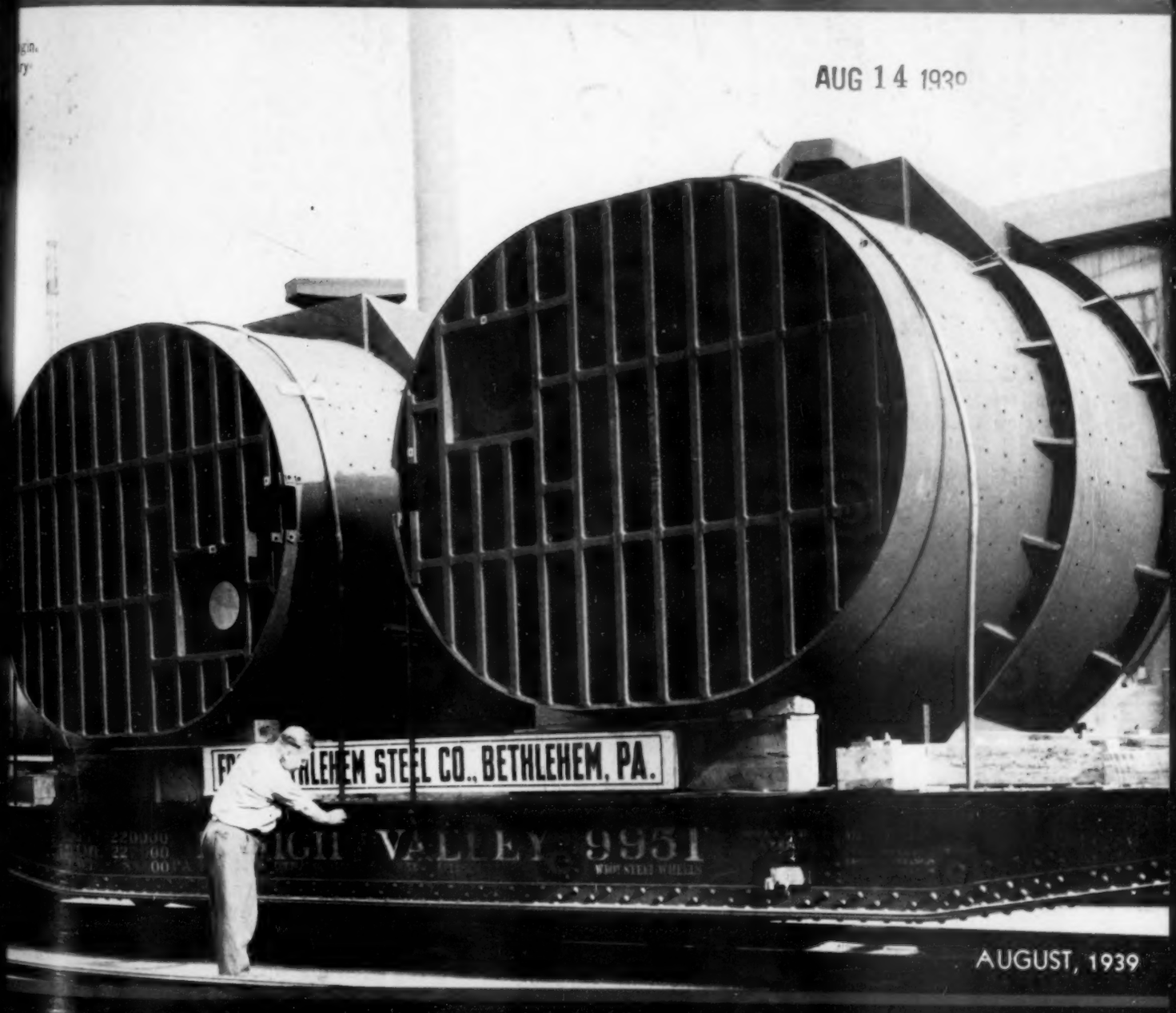
The Welding Journal

AUG 14 1939



AUGUST, 1939

The Journal of the American Welding Society

2 NEW G-E ARC WELDERS

For Better Work—At Less Cost

(Left) 100-amp size Welding range: 25 to 150 amp. Handles 1/16-, 3/32-, 1/8-, and 5/32-inch electrodes

(Below, right) 200-amp size Welding range: 60 to 275 amp. Handles 3/32-, 1/8-, 5/32-, 3/16-, 7/32-, and 1/4-inch electrodes

Excellent results are obtainable with all good a-c electrodes, among the best of which are the following G-E types:

For welding in any position, Types W-25 and W-20.

For high-speed horizontal fillets and flat work, Types W-23 and W-24.

For high-tensile steel, Type W-54.

For cast-iron repair, Type W-80 and Type A.

WELDING light-gage steel is especially easy with either of the new G-E alternating-current arc welders because continuous control of current provides the exact adjustment needed for best results. On heavier work, too, better results, are obtained more easily, as arc blow is absent.

Because of their excellent stability, arc welding can be done in the vertical and overhead positions as well as in the flat and horizontal positions. Mild steel, high-tensile steel, cast iron, or any other metal for which suitable a-c electrodes are available can be arc-welded with either of these new welders.

Power costs are 40 to 50 per cent lower than with welders of the rotating type because efficiency is higher, idling losses are lower, and maintenance is practically negligible.

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These welders are priced at less than $1.00 per ampere, and we believe you will agree that they offer values which are second to none. These and all other types of arc welders, accessories, and electrodes are available through G-E arc-welding distributors or G-E sales offices. Ask one of them today for a demonstration, for a trial, or for help with your welding problems. Or send the coupon to General Electric Company, Schenectady, N. Y.

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Schenectady, N. Y.

Please tell me how I can use these welders to advantage on my type of work. (Attach description.)

Please send me bulletin GEA-3081

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The American Welding Society Journal

W. SPRARAGEN, Editor

Published for the Advancement of the Science and Art of Welding

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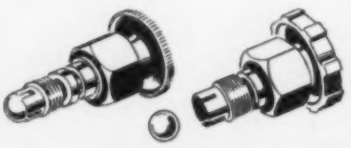

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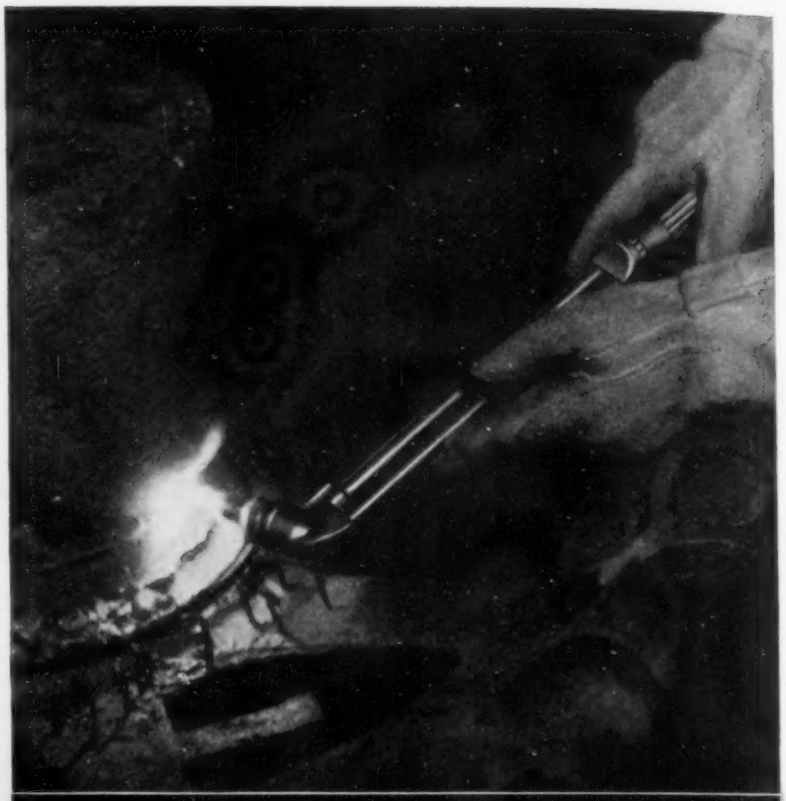

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Welding Journal

VOLUME 18, No. 8 AUGUST 1939

The MANUFACTURE of BOILER PLATE*

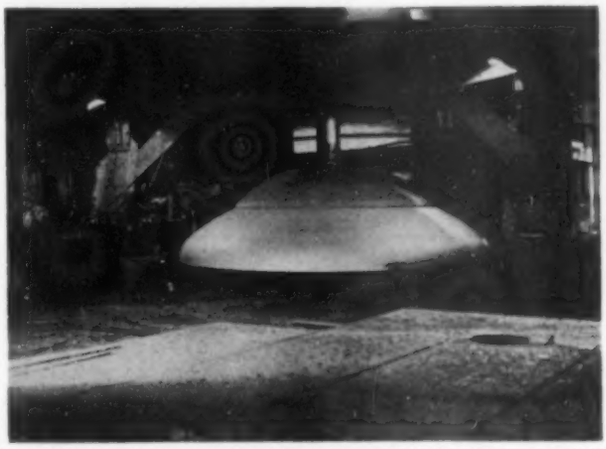
By DR. W. G. THEISINGER†

THE manufacture of boiler plate in the United States has run the gamut of the series of processes developed for the making of iron or steel. Although the skeptics looked upon each succeeding method as a "new fangled process" that would not last, let alone take the place of the existing popular process, engineers, on the other hand, hoped that each new method would bring the desired improvement in quality of material.

The demands of industry and the cooperating efforts of technical and practical research have brought about the present developed state of the art of steel making. The use of specifications and the inspection of materials for boilers and pressure vessels has kept pace with the development of production methods with the result that higher quality and greater operating safety are now assured.

In addition to the A. S. M. E. S-1, or 55,000 to 65,000 pounds per square inch tensile grade, there is now available a group of steels of higher tensile properties. Greater service pressures and temperatures are possible by the use of the high strength steels, thereby employing less thickness than if the lower tensile grade were used. The 70,000 pounds per square inch minimum tensile steels have been adopted for many vessels and the forming and welding of such material has assured regular shop routine. Most of this steel has gone into vessels constructed in accordance with par. U-68, requiring X-raying and stress relieving.

Our experience with specifications for boiler plate steel dates back to the beginning of its use. The original requirements were similar to the common mild steel grade



Hot Spinning the Largest Head Ever Formed in One Piece. It Is 216 Inches O.D. x 1 1/16 Inch Thick

of the present, calling for approximately 55,000 to 65,000 pounds per square inch, with proportional yield point and ductility values. However, the steels of later acceptance, no doubt, are of more interest in that higher physical properties obtained by these plain carbon and low-alloy steels have affected to some extent the fabricating procedure through the introduction of welding.

By a combination of chemical elements, the desired physical properties are obtained not only in the plate material, but also in the deposited weld metal. There

A. S. M. E. S-27 A. S. T. M. A-150-38

High Tensile Strength Carbon-Silicon-Steel Plates for Boilers and Other Pressure Vessels.

2 1/2-In. Plate (Stress Relieved)

Tensile	Yield	El. 8 In.
77,600	46,900	28%

0.505 All-Weld-Metal (Stress Relieved)

Tensile	Yield	El. 2 In.	Red.
77,000	61,250	30%	62.3%

Reduced Section (Stress Relieved)

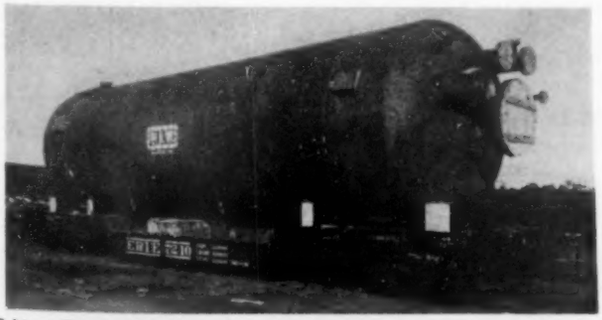
Tensile	Yield	Fracture
76,780	46,000	Edge of Weld

Chemical

	C	Mn	P	S	Si	Mo
Plate	0.27	0.72	0.016	0.024	0.23	...
Weld	0.09	0.51	0.021	0.017	0.19	0.57

* Abstract of paper presented before National Board of Boiler and Pressure Vessel Inspectors' Convention in New York City, May 16th.

† Welding and Metallurgical Engineer, Lukens Steel Company, Coatesville, Pa.



Coking Drum, 12 Feet in Inside Diameter, 80 Feet in Over-all Length, One of Four Fabricated from Plates and Heads of Lukens Thermal Steel by the Petroleum Iron Works Company, Sharon, Pa., for Operation at Pressures Up to 400 Lb. per Sq. In. and Temperatures Up to 900° F., in a Petroleum Refinery. Each Drum Weighs About 280,000 Lb.

A. S. M. E. S-28 A. S. T. M. A-202-37T

Chrome-Manganese-Silicon Alloy-Steel Plate for Boilers and Other Pressure Vessels.

1 1/2-In. Plate (Stress Relieved)

Tensile	Yield	El. 8 In.
81,000	58,000	23%

0.505 All-Weld-Metal (Stress Relieved)

Tensile	Yield	El. 2 In.
91,000	78,000	22%

Chemical

	C	Mn	Si	Cr	Ni	Mo
Plate	0.16	1.35	0.74	0.52	..	..
Weld	0.14	0.65	0.15	0.31	1.00	0.80

A. S. M. E. S-43 A. S. T. M. A-203-37T

Low-Carbon-Nickel Steel Plates and Other Pressure Vessels.

1-In. Plate (Stress Relieved)

Tensile	Yield	El. 8 In.
75,000	52,000	26%

0.505 All-Weld-Metal (Stress Relieved)

Tensile	Yield	El. 2 In.
80,000	67,000	26%

Chemical

	C	Mn	Si	Ni	Mo
Plate	0.17	0.75	0.21	2.25	..
Weld	0.10	0.54	0.08	2.30	0.29

A. S. M. E. S-44 A. S. T. M. A-204-38

Molybdenum-Steel Plates for Boilers and Other Pressure Vessels.

3-In. Plate (Stress Relieved)

Tensile	Yield	El. 2 In.
75,000	55,000	28%

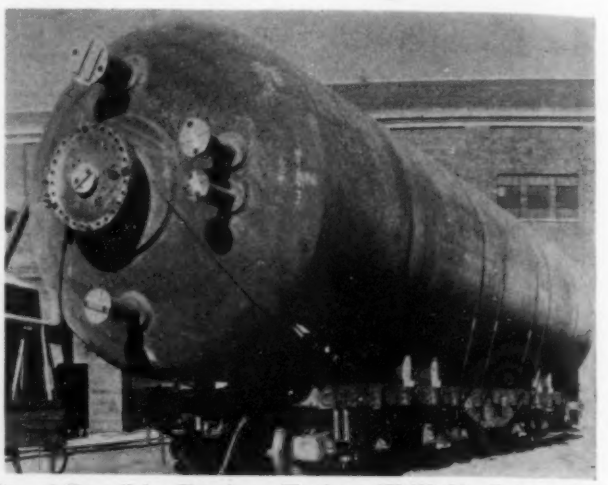
0.505 All-Weld-Metal (Stress Relieved)

Tensile	Yield	El. 2 In.
73,000	55,000	32%

Chemical

	C	Mn	Si	Mo
Plate	0.20	0.83	0.24	0.48
Weld	0.11	0.64	0.10	0.53

are a number of welding rods available for the higher tensile steels with possibly as many varieties of chemistry in their make-up. The so-called 70,000 pounds per square inch minimum tensile steels for boilers and other pressure vessels are listed below with typical physical and chemical properties of the plate and corresponding values for the deposited weld metal.



One of Four Coke Chambers, Weighing 275,000 Lb. Each, 13 Feet Inside Diameter, 61 Feet 6 Inches Over-all Length, 2-Inch Wall Thickness, Designed to Operate at 150 Lb. per Sq. In. and 900° F., Fabricated by A. O. Smith Corporation, Milwaukee, Wisconsin. All of These Four Vessels Used Elliptical Heads, 13 Feet Inside Diameter, Weighing Nearly 12 Tons Each, the Largest of Their Type Ever Made

In conclusion: We have come to accept the 70,000 pound per square inch minimum tensile steels for pressure vessels within the past few years, and while they have brought some welding and other fabricating problems, these problems have been overcome and shop procedures have been established. There are now other alloy steels available and it may be that at least some of these will be incorporated into the existing codes. Some go beyond the present range to 90,000 and 100,000 pounds per square inch tensile strength, and though it is to be expected that their fabrication will require careful control, experience and research can develop the methods of operation.

There are limitations on the size of boiler plates that can be made, but the needs so far have been satisfied. For example, one fabricator has received carbon-molybdenum plates that are 387 1/2 in. x 95 in. x 4.66 in., weighing 50,000 pounds a plate. The ingot weight for each ingot was 90,000 pounds, yielding 53 per cent of plate material.

Annual Meeting Program

The Annual Meeting of the AMERICAN WELDING SOCIETY will be held in Chicago during the week of October 22nd in conjunction with the National Metals Exposition. The National Program Committee has arranged sessions on the following subjects; Welding in Construction Work, Industrial Research, Production Welding in Light Gauge Material, Fundamental Research, Machinery Construction, Welding in General Construction, Flame Hardening and Hard Surfacing, Resistance Welding, Welded Piping, Pressure Vessels and Boilers, Cutting and Welding in Steel Mills, Welding in Structural and Ship Work, Railroad Session and a Miscellaneous Session.

Altogether some sixty papers will be presented.

Indications are that more than a thousand welding engineers will attend the various technical sessions of the Society. No one can afford to miss this opportunity.

RECLAIMING A NICHROME CASTING

By A. E. SPECK*

WHERE castings are subjected during use to high temperatures and corrosive atmospheres, alloys of chromium-nickel-iron composition are often used. Each of these alloys presents an individual welding problem due to different metallurgical characteristics introduced by the alloying elements. However, the flexibility of the oxyacetylene process is such that, by slightly changing the welding technique, nearly all of the present-day metals of this type can be successfully joined. Careful consideration of proper welding procedure should enable almost any competent contract shop to handle profitably work of this nature.

NICHROME CASTING FOR ANNEALING FURNACE

One example of such careful procedure in welding was the repair of a lower sand seal for an annealing furnace. After three years' constant use, this 300-lb. Nichrome casting had developed a total of 45 cracks. It was repaired by welding at a fraction of the cost of replacement and its return to service was a matter of only hours rather than of days or weeks.

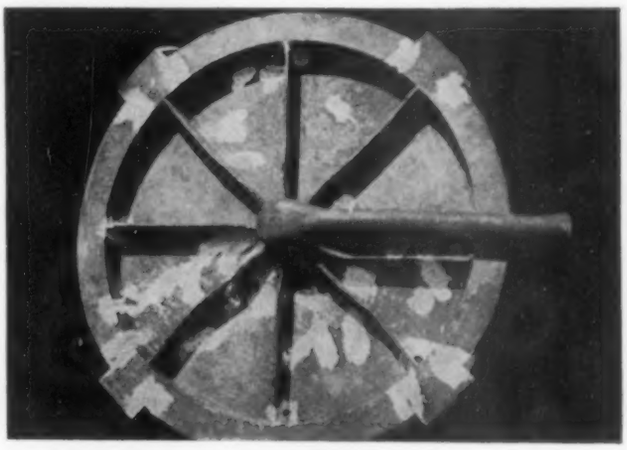
PREPARATION OF CASTING AND PREHEATING FURNACE

When it was removed from the annealing furnace, the casting was found to be burned and extremely dirty. In order to locate all cracks, and thoroughly prepare it for welding, it was first necessary to clean the casting of all scale and dirt. Next each of the fractures was carefully veed to provide a clean surface for welding and to assure thorough penetration through each section.

As protection against the formation of scale and oxides during preheating and subsequent welding, a water-mixed paste of Cromaloy flux was applied to all cleaned and beveled surfaces. The prepared casting, well-supported against possible heating stresses, was then placed in a preheating furnace construction of firebrick. Charcoal was packed around the casting and additional

* Dominion Oxygen Company, Ltd.

The Casting Was Preheated by a Charcoal Fire in a Temporary Furnace to Almost a Red Heat



The Veed Surfaces of the Casting Were Protected from Scaling and Oxidation by a Water-Mixed Paste of Cromaloy Flux

firebricks were used to support an asbestos paper cover for the furnace. This covering served to retain heat in the furnace and to prevent uneven temperatures in the casting.

PREHEATING

After a number of small holes had been punched in the asbestos covering in order to assure admission of the correct amount of air into the furnace, the blowpipe flame was used to light the charcoal. An even lighting of the preheating fire was a simple matter since draft holes had been left on all sides between the bricks which made up the preheating furnace. Once the casting was brought to almost a red heat, additional charcoal was added to the fire when necessary and the entire casting was kept at this temperature until welding was completed.

WELDING PROCEDURE

Actual welding was carried on through an opening in the asbestos cover, the size of the opening being kept as small as possible without materially hindering manipulation of the blowpipe. Although the carbon content of this particular casting was sufficiently high to have allowed a very slight excess of acetylene in the welding flame, the operator was careful to maintain a neutral flame throughout the welding operations.

His excellent judgment in this respect is readily apparent when the importance of the correct flame for welding metals of the chrome-nickel-iron type is considered. An oxidizing flame will cause the formation of an excessive quantity of infusible oxides and will lead to porosity in the weld metal. On the other hand, an excess of acetylene will increase the carbon content of the weld and adjacent metal and reduce the resistance of the alloy to corrosion. The correct neutral flame should be obtained by first supplying an excess of acetylene and then

cutting back the flow until the acetylene feather just disappears. Any very slight excess of acetylene present in the flame adjusted according to this procedure will not materially affect the welds obtained with it. In addition, the flame should be no larger than is necessary to obtain proper fusion, so as to avoid the possibility of overheating.

To obtain complete penetration as the welding progressed, additional Cromaloy flux was used with the Nicroloy welding rod. The location of the opening in the asbestos covering was changed from time to time as the operator proceeded from one weld to another, care being taken at all times to keep the opening as small as possible. Each weld was completed in the shortest time consistent with good workmanship. Puddling was avoided since such action has a tendency to cause porous, weak welds in castings of this type. Instead, the rod was allowed to flow onto the thoroughly melted base metal and fuse with it.

AFTER-TREATMENT

When welding was completed, any possible hardness and brittleness in the welds and adjacent metal were removed by heat-treating. The casting was reheated to a dull red and completely covered so that it would cool slowly. When it had cooled, the welds and the metal affected by the welding heat were found to be as strong and ductile as the original base metal and the casting was ready to be returned for service in the annealing furnace.

Preparations for welding took 10 hr., while actual welding time was only 7 hr. Delivery of a new casting would have taken from two to three weeks at a cost much greater than that of repair by welding.

AGRICULTURAL USES OF WELDING and Cutting*

By MILLS H. BYROM†

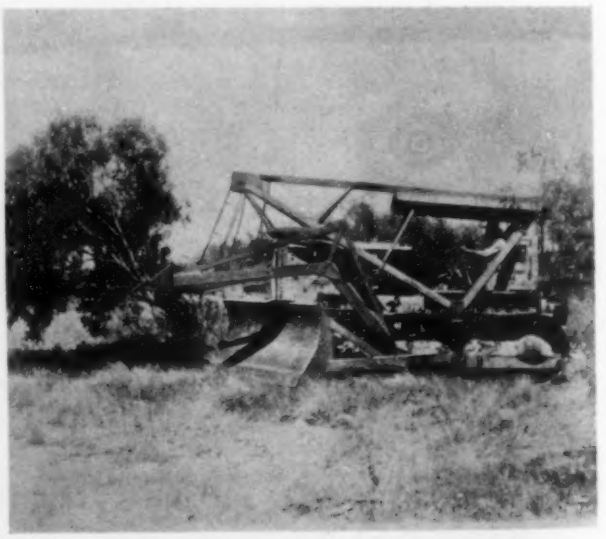
THE mechanization of agriculture began in earnest about 1850. Since that time the average number of acres of improved land per agricultural worker has increased from 30 to 50, and the investment in farm machinery per worker has increased from $40 to well over $300. In spite of all this progress it appears that the utilization of machinery in connection with agriculture is on the threshold of a new day.

The past five years have seen the general-purpose tractor with a full line of attachments become firmly established. They have also seen many implements change from steel tires to rubber. The next five years should see some revolutionary implement design due to rubber tires. There will also be many improvements in manufacturing processes. The results should be better and cheaper machines. Modern developments in the application of the oxyacetylene process to production problems should increase its use in the manufacture of farm implements.

At the present time flame cutting is employed to some extent by several large manufacturers. In most cases a master template is employed with a machine of the pantograph type to guide the torch in cutting irregular shapes. Typical jobs are the radiator shell and bumper of a tractor. Certain types of cutting and blanking dies are roughed out with the torch and in some cases small sections or projections are welded on. This saves expensive die steel as well as machining.

Interest in the Government program of land conservation and use has brought about the development of some new machinery. Several new terracing machines, which are somewhat larger than the old style terracers, have been developed. Many parts on these machines are flame cut. Clearing land of mesquite and brush has led to the development of a large bull-dozer (better known as a tree-dozer) attachment for uprooting larger trees and the U-shaped brush plow for clearing out brush and smaller trees. The heavy steel used in constructing these machines is mostly flame cut. The welding, however, is done largely by the arc.

Manufacture of some of the parts that go into the fabrication of farm machinery is highly specialized. Among these are malleable castings and the more complicated steel stampings. The manufacture of parts of this kind is usually contracted to companies equipped to produce them. In some instances the malleable castings



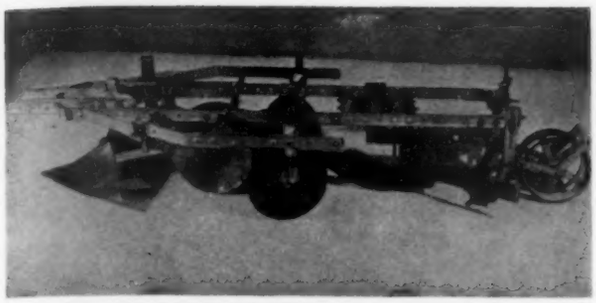
Tree-Dozer, Used to Uproot Large Trees. The Heavy Steel Used in This Attachment Is Probably All Flame Cut

are being replaced by welded steel parts when the cost is the same or less. This gives the implement company better control of production.

At the present time a large tonnage of implement parts is being fabricated by means of welding. Most of these parts are made from regular rolled steel sections, cut and

* Presented at the 29th Annual Convention of the International Acetylene Association, Houston, Texas, March 8, 9 and 10, 1939.

† Division of Agricultural Engineering, Texas Agricultural Experiment Station, Agricultural and Mechanical College of Texas, College Station, Texas.



Sub-Frame to Which All Soil Moving Tools Are Attached on the Experimental Cotton Planter

forged to shape and then welded. About 95 per cent of the welding is done on manually operated arc welders. The process of hard-facing steel parts to increase their wearing qualities has been left largely to the local repair shop and will be discussed later. Some parts, however, which are subjected to excessive wear or abrasion are now being hard-faced at the factory.

The oxyacetylene torch is used extensively in the maintenance and service departments of most implement companies. In maintenance work, welding, cutting, hardening, and softening are uses to which the torch is put. One service department sent a man into the field to service a new tractor attachment. He was expecting to make a few minor adjustments and carried only his kit of hand tools. Upon arrival he found a two-inch steel tube one-half inch too long. Sawing off that tube took two hours of hard work, 18 hack saw blades, and a skinned hand. A cutting torch would have turned the trick in less than five minutes. Experience of this kind are causing an increasing number of service departments to include welding and cutting equipment in the service kits.

Most implement companies maintain a large experimental department to design and test new machines. The torch is used extensively in this work. In many cases it is carried to the field and parts are welded on or cut off as the need arises. One factory sent a machine to Texas to be tested and improved. After a few trails in the field a local machine and welding shop was chartered, and the machine was completely redesigned and rebuilt.

A paper on this subject would be incomplete if the repair of farm implements were omitted, for it is probably in repair work that oxyacetylene welding has its first connection with agriculture. Its present importance can hardly be over-estimated. Not many years ago competent welders were scarce in the small towns and rural sections. Poor jobs turned out by "metal melters" instead of welders caused many farmers to shy away from oxyacetylene welding. This condition has been remedied to a great extent, and the demand for welding on the farm is increasing. The following example shows the service that welding can be to the farmer:

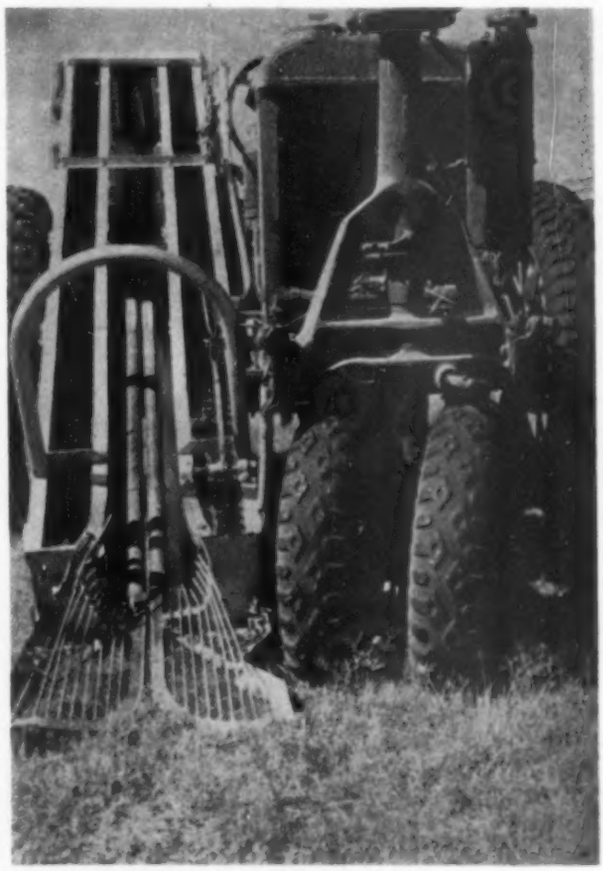
The rear axle housing on a tractor split in several places at the outer axle bearing. The cost of a new housing was close to $300, and it had to come from the factory. It would be necessary to dismantle the whole tractor before the new housing could be installed. A local welder was called and the housing bronze welded with only local preheating and very little dismantling. The cost was less than $10. It is needless to say that this Bell County farmer became a booster for acetylene welding.

The problem of disposing of worn out junked automobiles offers the local welder an added use for his welding and cutting equipment. A well-built two-wheel trailer can be constructed from the front or rear axle of an old car at a cost ranging from $10 to $50. A good four-wheel trailer can be built for about the same amount. Some shops keep several trailers of both types on display. As they are sold, others are built. Other shops find it more profitable to build to farmers' specifications and wait until the trailer is sold to build it. Usually some means of attaching the trailer to the car of the buyer has to be provided. This offers the local repair man still further profitable use of his equipment.

Hard facing of steel parts on agricultural implements to retard wear has had a steady growth in recent years. The process consists of welding a hard abrasion-resisting alloy on the surface of any part of an implement which is subjected to wear. This protection is particularly applicable to soil moving tools, thresher teeth, pulverizer hammers, mower sub-soles, bean cutter knives and many other parts.

Several patented alloys on the market may be used for hard facing. The selection of a particular one should be governed by the part to be faced, the type of abrasion to which it is subjected, and perhaps several other factors. The companies manufacturing these alloys furnish complete instructions for their application as well as suggestions for the selection of the best alloy for a particular use. With this information a welder of ordinary ability should have little difficulty in applying hard facing alloys.

In the past, plow manufacturers have recommended various types of shares for specific conditions. The type of soil, moisture conditions, and previous crops are factors influencing the life of plow shares. The application of a hard facing alloy to a steel share should increase its life about five times. In tests at College Station, untreated shares averaged 6 acres before being sharpened.



A Close-Up View of the Pick-Up Fingers and Knurled Steel Stripping Rolls of the Texas Station Cotton Harvester

Under more severe conditions in the same field, treated shared averaged 28 acres before needing attention. The Idaho Agricultural Experiment Station reports that untreated shares were sharpened four times before treated shares needed attention. The wear ratio was 5.66 to 1. Tests made by individual farmers and commercial companies show about the same results. The cost of hard facing will vary from $2.00 to $4.00, depending on the size of the share and local shop conditions. A new share properly treated should outwear three new shares which are untreated. This means a saving to the farmer of as much as 50 cents per acre in some cases.

For many years the production of cotton has been the most important agricultural enterprise in Texas. The plowing, planting and cultivating of this crop have been largely mechanized for large-scale production. The problems of chopping and harvesting, however, have never been solved to the satisfaction of the farmer. The Texas Agricultural Experiment Station has contributed to every phase of cotton production and for several years has been working on the designing of cotton planting and harvesting machinery. The planter with which most of our experimental plants are planted has a sub-frame to which all soil moving tools are attached. Most of these tools are welded or brazed to standards which, in turn, are bolted to the sub-frame. This type of construction simplifies the many adjustments necessary in experimental work.

Mechanical cotton harvesters are of two general types. One type removes the cotton from the bur as the hand picker does. The other removes the boll from the plant and requires an auxiliary machine to remove the cotton from the bur. They are commonly called spindle pickers and strippers. The Texas Station Harvester is of the stripper type. In constructing this machine, all built-up parts were made by welding or brazing sections together. Very few castings were used. The pick-up fingers, used to lift low-hanging bolls into position to be operated on by the stripping rolls, are the result of considerable experimenting. On several occasions the torch was taken to the field in order to save time in making necessary changes. In their present form the fingers consist of two $^3/_{16}$ x $1^1/_4$ inch flat steel strips curved to fit the contour of the ground at the base of the plant, gradually rising and coming parallel over the lower ends of the stripping rolls. Five-sixteenth inch rods are welded to the outer edges of the $^3/_{16}$ x $1^1/_4$ inch pieces parallel to the stripping rolls, forming a trough or cradle through which the limbs and bolls of the plant slide into the machine. As the plants pass between the knurled steel stripping rolls, the bolls are removed and dropped into elevators which carry them to the bur extractor. This unit separates the seed cotton from the bur.

The ends of the extractor consist of a framework built up of $^1/_4$ by $1^1/_2$ by $1^1/_2$ inch angle iron. Bearing supports were obtained by welding 10-gage iron to the framework. The lower ends of the angle iron support the extractor in operating position on the drawbar of the tractor. A set of fingers was made of $^3/_{16}$ by 1 inch flat steel brazed to 1-inch steel collars and mounted on a shaft in such a manner that every other finger could oscillate. This arrangement holds the cotton until it is removed by the main extractor saw. The burs and trash drop to a lower set of stationary fingers made of spring steel. These fingers guide the burs and trash under a reclaimer saw, which salvages any cotton in the trash and returns it to the main saw. The seed cotton is doffed into an elevator which takes it to a trailer.

An Experimental Cotton Planter and Fertilizer Distributor in Operation Near Nacogdoches, Texas

In the erection of an experimental dehydrating plant to be used in the artificial drying of garlic, the furnace was welded up from 18-gage galvanized iron. Eighty tubes, 3 inches in diameter, were welded into headers similar to the tubes in a fire tube boiler. In operation the air passes through the tubes and into the garlic. The flames or heat pass around the tubes.

The garlic bulbs are ordinarily plowed from the ground and piled in the sun for several days. In some instances sun blister has resulted from this practice. To avoid piling the garlic in the hot sun, the Experiment Station designed and built a digger to run under the bulb and leave it in loose soil to dry. The blade and other parts of the digger were welded in order to get the desired shape and strength.

For several years ranchmen in the Edwards Plateau region have been interested in eradicating prickly pear and other noxious plants by means of poisons. The Division of Agricultural Engineering has cooperated with the Ranch Experiment Station at Sonora, Texas, in designing equipment to apply the poison and in testing various poisons. Several types of stabbers and sprayers have been built. The most effective poison has been found to be arsenic pentoxide in a solution of sulphuric acid and water. To properly atomize this solution, a pressure of 125 per square inch is required. Ordinary ferrous metals will not stand up under these conditions. Tests indicate that a sprayer made of 18–8 stainless steel would give satisfactory service.

The demand for a small single-head grain sorghum thresher became so great that in 1936 the Division of Agricultural Engineering designed and built one. The threshing unit was of the modified rasp type. The cylinder was made from an old cast-iron pulley and was mounted in self-aligning ball bearings. All other parts were of mild steel. Welding was employed wherever possible in the construction of this machine.

OXYACETYLENE APPLICATION of Hard Facing Materials to Oil Well Drilling Bits*

By CHARLES H. SHAPIRO†

EARLY WELDING RODS

THE very earliest attempts at surfacing fishtail bits with an acetylene torch were made by applying cast iron, tool steel, etc. These materials, though they may not have been the most efficient, were the forerunners of metals which had very desirable qualities. Further development produced the metals in general use today; which from our present viewpoint can be considered eminently successful. These early rods, as surfacing materials, were followed by a special type rod made up of a powdered element or alloy, which together with an ordinary mild steel rod were encased by a thin closed strip or tape of low carbon steel. This was the first successful over-lay application, and because of its characteristic of becoming hard on deposition, was termed "self-hardening." All the old-timers remember this rod, and even today it finds applications in many fields. Claims first made for this new surfacing metal were quite out of reason.

ACETYLENE APPLICATION OF HOMOGENEOUS TYPE RODS

This rod was soon followed by a material, cast in the form of a welding rod, made by combining chromium, tungsten and cobalt metals to form a uniform, homogeneous alloy. Its technique of application was quite similar to the materials previously deposited by the acetylene torch. This alloy had a higher quality of resistance to abrasion than had the other hard-surfacing metals of that day. The introduction and use of this alloy all but displaced the old method of dressing and tempering fishtail bits. Its success soon caused a flooding of the field with other homogeneous hard-surfacing rods, some quite similar, many containing different elements in varying quantities. The original material, along with a composition made by another manufacturer, was superior to the others and soon found wide-spread use.

In the main, the advantages resulting from a welded-on overlay as compared to the tempering method were greater dependability, longer life and increased footage drilled. Drilling operators had long desired, and were ever alert for bits with these characteristics. Even at considerably higher cost than the tempered type, hard-surfaced bits became increasingly popular.

The acetylene application of homogeneous type rods is quite simple. After short acquaintance one can easily apply this material. The surface to be faced is first cleaned, ground of oxides and scale. The area to be surfaced must be preheated. For proper deposit, the flame of the torch is adjusted so as to contain an excess of acetylene. (See Fig. 1.)

The base metal is first brought to a sweating heat; the end of the rod is then dipped into the flame and the molten metal deposited onto the sweated surface. Correctly applied, the metal will flow and spread similar to solder on a hot, tinned surface. The deposit should be built-up to the desired thickness in one operation. "Puddling" is not recommended. Specks of oxide should be "floated out." This can be easily accomplished by proper manipulation of the torch; the specks being actuated by the pressure of the hot expanding gases from the torch.

INTRODUCTION OF TUNGSTEN CARBIDES

Following the homogeneous hard-surfacing rods, came the introduction during the years 1927–28 of diamond substitutes called tungsten carbides. Tungsten carbide in irregularly shaped piece or slug sizes was at first quite expensive, at one time selling for $320.00 per pound. Despite its high cost, the advantages in its use became apparent and desirable. Increased usage, because of its ability to resist abrasion, necessitated production of this new metal in quite large quantities, materially reducing its selling price. Various other forms of this material, having distinct application advantages, were soon afterward developed, the most important of these being the filling of thin-walled tubes or sheaths with crushed and graded particles of this metal. It was found in application that the tube could be handled as easily as an ordinary welding rod, and that the metal of the tube after deposition acted as a binding material, fusing itself to both the base material and the tungsten carbide grains. Composite or amalgamated rods, made by previously melting low carbon steel onto graded crushed, irregularly shaped tungsten carbide granules so as to form a rod or stick, act similarly to tubes filled with crushed metal. (See Fig. 2.)

Tungsten carbides, as used today, fall into two general classifications; sintered carbides, used mainly for metal cutting; and cast carbides, used as hard-surfaces for cutting edges of earth-boring tools, as well as other applications for the resistance to wear and abrasion. The sintered carbides, due to the expense involved in manufacture, are quite high in cost and do not find application as hard-surfacing materials on oil well

Fig. 1—Flame Containing Excess of Acetylene

* Chief-Metallurgist, Reed Roller Bit Company, Houston, Texas.
† Presented at the 39th Annual Convention of the International Acetylene Association, Houston, Texas, March 8, 9 and 10, 1939.

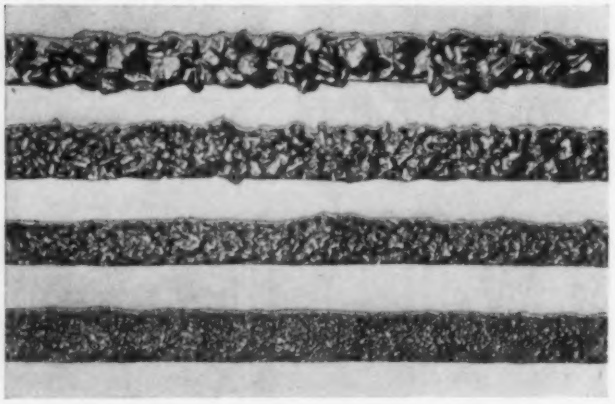


Fig. 2—Composite or Hard Facing Rods

drilling bits. The cast carbides being manufactured by a fairly simple and not overly expensive melting procedure, find wide-spread use and application on tools for abrasion resistance. The cost of the cast carbide is only nominal as compared to the compressed and sintered carbides.

Cast or fused tungsten carbide as used for hard-facing material, can be purchased in the form of pieces with special or standard shapes. (See Fig. 3.) These are termed inserts. This material is also available in broken, irregular pieces of medium size called peas. It may also be purchased as composite metal, tube metal, or as crushed, bulk material, graded and numbered according to the mesh screen through which it will pass.

The early application of tungsten carbide was only in the form of inserts or "slugs." These were set onto the cutting blades and covered with some type of homogeneous hard metal. Today this metal is applied in two of the above forms on the same bit cutting wing. The inserts are set partially into the base material surface after melting a spot or grinding a groove to accommodate them. After setting, the inserts and surface adjacent is covered with tube or composite metal. A detailed account of hard surfacing will follow.

Though one does not necessarily have to be an expert acetylene welder to hard-surface a drilling bit properly, some experience in the correct method of setting inserts and in the handling of an acetylene torch is required. The human element is of great importance, and one must understand the characteristics of the metals being worked with; he must be aware of the correct way of accomplishing the desired aims, and must exercise judgment and care during the entire welding procedure. Good oxyacetylene equipment and accessories are also of prime importance.

For saving time and for proper manipulation of the worn bit during the welding operation, a correctly designed fixture or holder is indispensable. This fixture should be arranged so that a welder can turn, change the level of, gage and build-up the worn bit to a true center with the axis of rotation, without expenditure of too great an effort and without leaving the welding position. Holders are especially useful in the building-up of large, heavy fishtail bits. Many welders have built efficient, ingenious bit holders to aid them in their work. Some suppliers also market bit holders that are marvels in their simplicity and efficiency.

A further adjunct to the building-up of bits of all kinds is a grinder or grinding machine for preparing surfaces for welding, and for the grinding of cutting and reaming edges to exact gage dimensions. Many hand, portable and stationary type grinding machines can be purchased that are well suited for this type of work.

BUILDING UP WORN BLADES

In building up a worn blade, it is necessary to weld out from the worn or cut-away edge, with a material that has physical characteristics approximating the original base metal. There are many rods upon the market that have these desired qualities. The deposit from a rod which will contain from 0.35 to 0.45 per cent carbon are most suitable.

In order to properly flow and control the molten metal from the "building-up" rod, a copper back-up template or form is used. The copper form is generally $^1/_4$- or $^3/_8$-inch rolled copper plate, curved slightly or formed according to the shape of the bit and the desires of the welder. The copper plate is indispensable, much time being saved by its use. Control of molten metal, and of the building up of shoulders, gage edges and the like, is easily accomplished when it and the holder are properly manipulated. Carbon blocks have been and are still used by some operators in place of copper forms.

The first step in the building-up of worn fishtail bits is to properly mount the bit in the fixture or holder. The reaming edges and "vee" between the blade should be lined-up with the pin or axis of the bit. The old, remaining hard metal should be removed by "washing-off," with a cutting or welding torch flame. The cutting and reaming edges are then trimmed, ground and conditioned for the weld deposit to follow.

The edge of the trimmed wing, and the adjacent area are first brought to a dull red heat, approximately 1300° F. by heating with the acetylene torch. This is in the nature of a preheat and protects the weld and surrounding section from strains, thermal shock and possible heat checks. One blade is built-up at a time. The copper template or form is fastened to the underside of the bit wing by using flexible clamps, having spring action, made of pieces of $^1/_4$-inch welding rod bent to a "closed U" shape. Adjustable "C" clamps can also be used. The surface of the copper plate is then marked off by means of a soapstone stick to the size and dimension of blade required. The tungsten carbide inserts are laid out upon the surface of the plate in the pattern desired. (See Fig. 4.) The wing or blade of the bit is then built out to its original shape. The inserts are first lightly

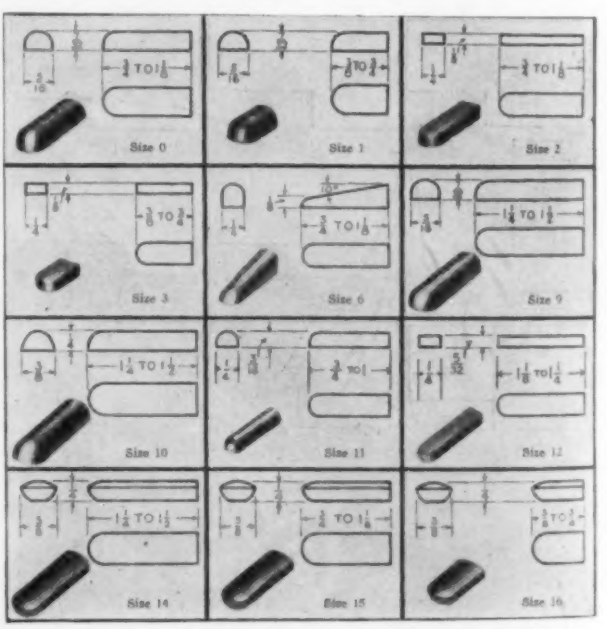


Fig. 3—Hard Facing Inserts

Fig. 4—Tungsten Carbide Inserts Are Laid Out in the Pattern Desired

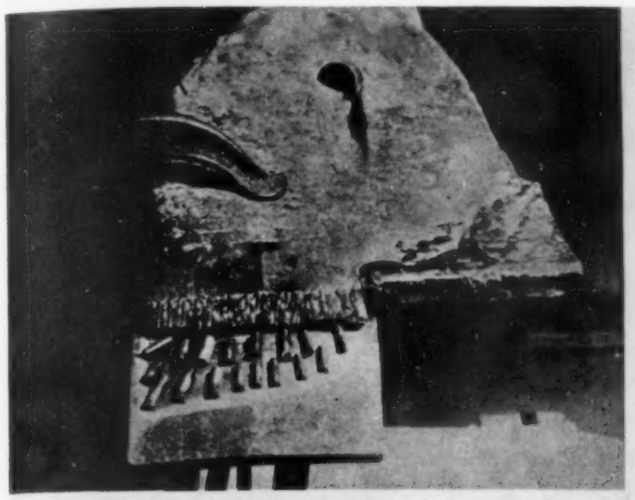


Fig. 5—Inserts Lightly Covered with Steel

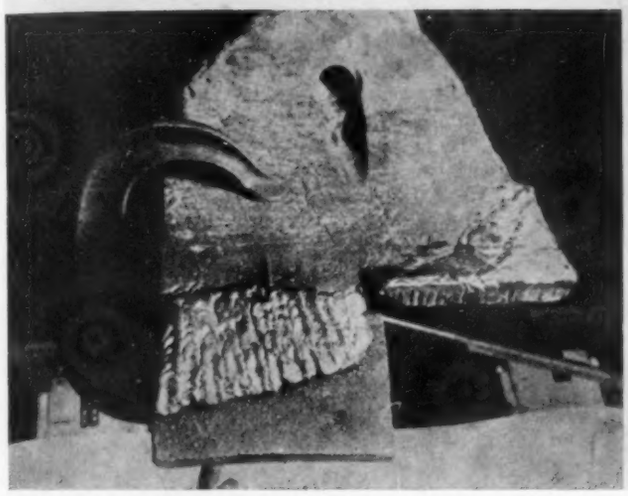


Fig. 6—Blade Rebuilt to Desired Thickness and Level

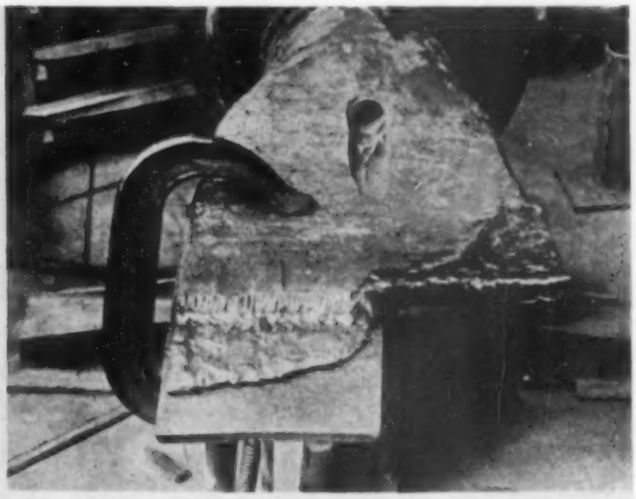
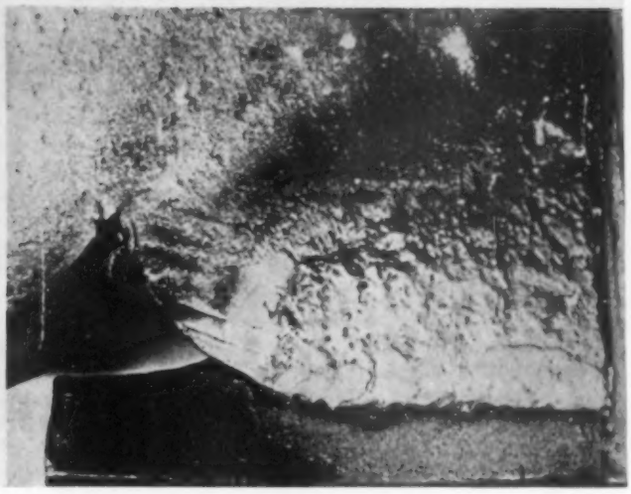


Fig. 7—Completely Dressed Blade



covered. The bit is then turned over, the copper template removed and steel applied. Steel is deposited until top and bottom faces of the blade are completely rebuilt to desired thickness and level. (See Figs. 5 and 6.)

The above is the most generally followed method of setting inserts (hard-setting) and building-up in use in field shops today. There are a great many variations of this method. Many deem it advantageous to build the blade out first and later set the inserts (this method is similar to the procedure used in hard-setting new blades and will be described later). Many use the electric arc to complete the building-up, after the inserts are set. Some use the electric method for the entire hard-surfacing process.

After setting the inserts and building the blade up to the necessary thickness, the surface is covered with either tube metal or composite rod with a size of grain as desired. The crushed carbide application acts as a wear-resisting surface against slush impingement. It also becomes the cutting edge as well as a protection for the inserts. Figure 2 illustrates composite or amalgamated rods. Note size of grain. The completely dressed blade is shown in Fig. 7.

The dressing of the reaming edge of a built-up blade is also of prime importance. Bit dressers use tube metal or amalgamated rod on reaming edges. The grain size is medium to fine; occasionally coarse material is used. Reaming edges are built-up full, somewhat beyond desired gage. In most cases a deposit of welding rod is used as a filler rather than to build-up a thick deposit of tungsten carbide because of the tendency to "flaking." Grinding and trimming is resorted to in bringing the bit exactly to gage. Further grinding accomplishes final shaping, sharpening and touching-up of the surface and edges.

After the building-up and surfacing of the first wing, the same operations are successively repeated in dressing and surfacing the remaining blade or blades of the bit.

NEW FISHTAIL BITS

New fishtail bits, or detachable welded-on blades, are hard-surfaced by a more or less standardized procedure. The blade surface properly cleaned is preheated to a dull red heat (1300° F.). The spot desired for setting the insert is heated until it becomes molten in an area somewhat larger than the size of the insert. Without letting the spot cool, the end of the mild steel rod is heated until it begins to "sweat," at which time it is touched to a hot insert and the two, further heated until they adhere. The hot insert is then submerged to the desired depth into the molten spot of the base metal, and positioned. Heating is then discontinued by removing torch from the spot. Slight cooling will allow the

spot to solidify, at which time the tacking rod is melted from the hard metal piece. These steps are repeated until all inserts of the blade are properly set, each in its desired position. Composite rod or tube metal, of grain size desired, is laid down, after a surface retouching, as a facing over the entire hard surface section of the blade. Following this, reaming edges are faced with crushed carbides. This procedure was detailed previously, in each of the steps used in the building-up of worn bit wings.

If the successive steps in the hard-surfacing application were carefully performed there should be but little trimming, with the acetylene torch or the grinding wheel, necessary. Bits will have to have some grinding done on reaming edges to bring some within exact dimensions required, since the layer of tube or composite metal was intentionally applied somewhat full.

Another procedure, followed extensively, eliminates the puddling or melting of the spot previous to setting the inserts. Instead, slots or grooves are ground in the new bit blade cutting and reaming edge face, to accommodate the inserts or other tungsten carbide pieces. The inserts are then bound by properly flowing in mild or high-tensile steel rod. The pieces are entirely covered and the grooves completely filled. The surface, as in previous cases, is afterward covered with the desired size of crushed metal in tubes or in the form of amalgamated rod. The reaming edges are built up as in previous procedures. Grinding, touching-up and gaging follow.

Still another method, though not generally used, is to similarly groove cutting and reaming edges as previously explained. The grooves are then filled with tube or composite metal. A thin layer of steel rod is applied previous to the finish surface deposite or layer of tube metal.

Correct hard-setting practice calls for a flame from a torch tip of a size sufficient to furnish the necessary quantity of heat. The flame should be adjusted to an acetylene excess, reducing in character. The inserts should be spaced approximately $^3/_8$ to $^1/_2$ inch apart and in positions as directed by experience. Figure 8 shows the recommendations of one of the manufacturers as to alignment and spacing of inserts. The position of the inserts on the blades will control the condition of the worn edges. Blades set so that the inserts are lined up in same approximate positions will show a "fingering" type of wear. Those spaced so there is no "tracking" will wear to a smooth, flat bottom edge. Inserts should be set back slightly over $^1/_8$ inch from the cutting and reaming edges, in order to allow for subsequent grinding to sharp taper.

HEAT-TREATMENT

The question of heat-treatment after the building-up and hard-surfacing operations is of considerable importance. There are a great many built-up bits that receive no treatment following the welding procedure. These have and will continue to give good field service. Their drilling efficiency is a silent testimony to the ability of the welder, the high state of development of the materials used and welding procedures followed. Only the highest praise is worthy of the effort, expense and time expended by the metal fabricators, the welding operators and well drillers, whose contributions are the primary cause for the present state of development.

The author however strongly recommends that the welding operation be followed by a treating procedure of some kind. A simple treatment and one which would greatly benefit ductility or toughness properties of the deposited section, consists in normalizing from 1550° F. A real effort should be made to closely estimate, gage or measure applied temperatures. Some oxidation of the exposed grain on the surface of the bit will be present after heating, but the loss will not measurably decrease its efficiency. Many shops accurately heat-treat bits and welded parts, especially those which have no threads or accurate surface measurements to maintain. Smaller pieces which can be set wholly within a furnace, such as wings of the detachable type, blades, core cutter heads, cutter parts, etc., are in the majority of cases heated to correct temperature and oil quenched.

SOFT FORMATION CORE BITS

The conventional soft formation core bit wings or blades are dressed in a similar manner to regular fishtail bits. The most commonly used procedure is to first mount the core head in the bit holder. A copper form is clamped or supported on the underside of the previously trimmed wing that is to be built-up. With a soapstone pencil, the plate is marked to show the outline of the new portion to be built.

It is not considered the best practice to attempt the welding-in of insert hard metal at the time the blade is built-up. The inserts are set after the building-up step is completed. As in other hard setting operations, the inserts are covered with a tube metal deposit. The gage and reaming edges are then also covered with a layer of tube metal. The grinding wheel is then used for smoothing high spots, sharpening and bringing wings to exact gage.

Special type coring bits, digging bits and reamer wings are processed in a similar manner to soft formation core bits.

ROCK BITS

Cutters or cones of rock bits have their efficiency and life materially increased by hard-surfacing applications. The present practice is to hard-surface at least one face of each tooth of the cutting members. The cutters which make contact with the wall of the hole, in addition to the facing on each tooth, have their gage or bevel edges also surfaced with hard metal.

Manufacturers of tungsten carbide products have in recent years brought out tubes of small diameters. The smallest size procurable upon the market is $^1/_8$ inch diameter. The introduction of the small tube has made it a simple matter to hard-surface tooth faces, even in the small sizes. The size of grain packed in this tube is termed 30–40 metal. These numbers are arrived at because only that crushed grain is used that will pass through a 30-mesh standard screen and will stop upon a 40-mesh standard screen. A tube having a $^3/_{16}$ inch diameter containing 20–30 is also well suited for surfacing of rock bit parts. The main problem in tube metal application to rock bit cutter teeth is to maintain sharp edges and slender teeth. All rock bit parts receive a heat-treatment after hard surfacing.

A new hard metal was introduced in recent years whose hardness qualities are derived from crystalline chromium-borides together with an unknown "X" crystal. The metal is much lighter in weight than tungsten carbide. It is claimed by manufacturers to have a hardness of approximately nine on the Moh's scale, which is somewhat below the hardness of fused tungsten carbide.

The metal is applied in the form of a paste made up of the tiny crystal particles (average 100 mesh). The procedure called "sweat-on" consists in spreading the paste on a clean surface, by means of a spatula, to an approximate $^1/_{16}$ inch, over the area to be covered. Time for thorough drying should be allowed before the

head of the torch comes in contact with the metal on the surface. The flame of the torch upon the crystals causes a "glowing" effect after a particular temperature is reached. This indicates a surface sweating and slight rising of the shallow, molten surface, which completely encases each of the "X" particles. On deposition the manufacturer states that "the chromium-boride crystals alloy with the base metal, while "X" crystals permeate through the mass as if held in an emulsion." Because of specific gravity, too much or too prolonged a heating will allow the crystal "X" to sink below the base metal surface, causing it to lose some of its desirable properties.

Deposits are being made by "sweating-on" tungsten carbide crushed metal with the acetylene torch and is proving eminently successful. It is understood that crushed metal is also being applied by means of the electric atomic-hydrogen process.

It is not recommended in this paper that worn rock bit parts be redressed or reconditioned by means of applying hard metals. All rock bit parts are locked or fixed in rotating position by welding the parts and assemblies in heads or holders. All new parts are hardened by heat treatment previous to assembly, and any application of an acetylene torch or electric arc will soften and render quite useless the piece receiving heat.

HARD FORMATION CORE BIT HEADS

This type core head has rotating cutting members similar in construction to rock bit cutter cylinders. The teeth of these are generally faced with tube metal as described in the rock bit application. The "sweating-on" process is also finding application to rock core bit cutting elements.

Bearing pins or journals of the friction type, ofttimes are used in hard formation core heads. These are generally recessed by machining the load carrying surface; later this area is filled-in by depositing a homogeneous type of hard-surfacing rod. Grinding is resorted to, after welding, to bring the journal to required diameter.

SLUSH TUBES

Most of the new type fishtail bits, rock bits, hard-formation core bits as well as special types such as wire line and retractable bits, have inserted and replaceable slush tubes or bushings. These are used to direct slush fluid, as well as to restrict it, so as to get a jetting action on the cutting edge of the blade. Forceful jetting action aids materially in keeping the cutting edge clean at all times and in all formations. The inside diameter of these bushings vary from $^1/_2$ to 1 inch. The restricted fluid passage of the bushing is subjected to a high slush cutting abrasive action and special hard metal materials are required. Here again one finds the homogeneous type hard metals used widely because of their abrasion-resisting abilities. The bushings are cast to required shape and set into position by oxyacetylene or electric welding, using mild steel rods.

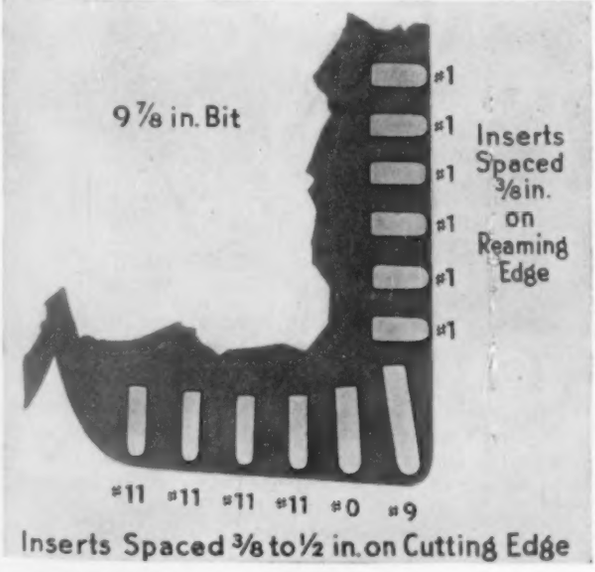


Fig. 8

DISK BITS

The use of disk bits in the "rotary" type of oil well drilling is on the decline. There are however some few certain sections of this and foreign countries whose formations are suited for drilling with a bit having circular disk cutters. Like in all other cases, application of hard-surfacing tungsten carbide metals materially increase the life and drilling efficiency of the cutting members. A new circular disk having a tapered cutting edge is hard-faced by machining a $^3/_{16}$-inch groove around its circumference about $^1/_8$ inch from the outside edge. The disk is then given a low preheat after which the groove is filled with tube or amalgamated rod until completely filled. The size of grain used for this operation is quite coarse.

Worn disk bit cutters cannot be reclaimed without a great deal of difficulty. By means of a cutting or welding torch, all old hard metal is washed away, followed by a trimming of the worn edge. The disk is then placed into a cast copper die having a shallow impression to exact dimensions of a new disk. By means of the acetylene torch high tensile rod is laid down until the disk is built up to full size and form. The piece is then properly machined with the $^3/_{16}$-inch groove, as above, and hard-surfaced in the same manner as a new disk. Very little trimming or grinding should be found necessary. Hard-surfaced disks, new or rebuilt, should be given some form of heat-treatment before assembly.

CABLE TOOL BITS

Because of the severe impact or hammering effect upon the cutting edge of a cable tool bit, necessarily applied because of its drilling action, considerable difficulty has been experienced in making hard-surfacing materials "stand-up." Homogeneous type metals have only been partially successful. The greatest success is as a result of careful control of details of welding and treatment and the use of fine-grained tube metal, not applied in too thick a layer. One of the hard-metal manufacturers suggests a change in the form of the cutting end of the bit from the "chisel" to the "hell diver" type.

Both new and re-dressed (re-forged) bit ends, for best results, should be in the normalized condition and pre-heated before application of the high-tensile steel undercoat. The end surface is then surfaced with high-tensile steel followed by hard carbide metal of fine grain size, 30–40 being suggested. Carbide having finer grain than 30–40 can be used with considerable success. The deposit from these tubes of fine grain carbides (80 grains and over), because of the solution and alloying effect, approaches a homogeneous deposit in character. A thin surfacing of this material should be comparatively free

of the property of "flaking" or "chipping." Another likely type of surfacing should be that of applying fine grain tungsten carbide by the "sweat-on" process. There are some accounts of cable tools being dressed with coarse carbide, with considerable drilling success resulting; however, this appears to be expecting too much from hard, brittle tungsten carbide under high impact loading action as is found in this type of drilling.

After the hard-surfacing deposition, the bit end should receive a heat-treatment to restore the ductility of the base metal. This may be done by heating uniformly, to an approximate 1550° F. temperature followed by a cooling comparable to an oil quench. The bit should be withdrawn before atmospheric temperature is reached, so that the heat on the inside of the bit may work its way through the hardened section and so act as a drawing treatment.

ACKNOWLEDGMENTS

The author wishes to acknowledge gratefully the help received from Welding Operators and Metal Manufacturers. They have been most kind in their cooperation and have extended to the author the use of pictures and slides depicting many of the hard-surfacing operations.

BRIDGE WELDING IN GERMANY*

By OTTO KOMMERELL†

SINCE welding was first adopted for bridges, over 150 railway bridges and 500 highway bridges have been welded in Germany. They have given remarkable service under the heaviest traffic. After being in service for six years the first welded railway bridge was subjected to thorough investigation at the National Materials Testing Bureau in Berlin-Dahlem. Despite the unusually heavy traffic to which the bridge had been subjected, not the slightest trace of damage could be detected, yet the welding had been performed under less strict supervision than is mandatory now.

The two exceptions to this excellent record are the Zoo Station railway bridge in Berlin and the highway bridge at Rüdersdorf‡ Fig. 1. Investigation of the fractured surface has shown that the crack in the Zoo bridge, which spread from a web-to-flange weld into the adjacent web and flange, must have formed while the weld was red hot during cooling after welding. The steel had the following composition:

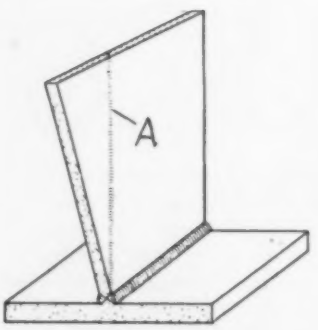


Fig. 2—Detail of Crack in Rüdersdorf Bridge. A = Butt Weld in Web

	Web (1.18 Inches Thick)	Ribbed Flange ($24^1/_2 \times 2.56$ Inches)
C	0.18	0.25
Mn	1.22	1.20
P	0.027	0.029
S	not determined	0.023
Si	0.37	0.80
Cr	0.10	0.02
Mo	< 0.10	...
Cu	0.40	0.50
N_2	0.0067	0.0120

A bead bend test** on the flange yielded only 18° bend with sudden failure. All things considered, it was concluded that the crack in the Zoo bridge owed its origin to excessive concentration of alloying elements in the steel. Improper composition led to excessive hardening in the thick flange, which cracked under the influence of shrinkage stresses.

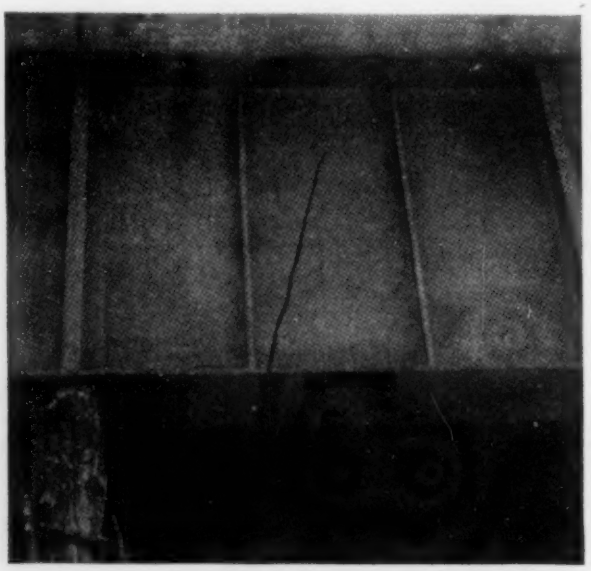


Fig. 1—Crack in Main Girder of Rüdersdorf Bridge

* Abstract of "Augenblicklicher Stand des Schweissens von Stahlbauwerken in Deutschland" published in *Bautechnik*, **17** (12) 161–163, (15) 218–221 (1939).

† Dr. Kommerell is an official of the Central Office of the German Railways in Berlin.

‡ Schaper, G. AMERICAN WELDING SOCIETY JOURNAL, **17** (8) Suppl., 32 (1938); **18** (1) Suppl., 14–15 (1939).

** Bierett, G., AMERICAN WELDING SOCIETY JOURNAL, **18** (1) Suppl., 17–21 (1939).

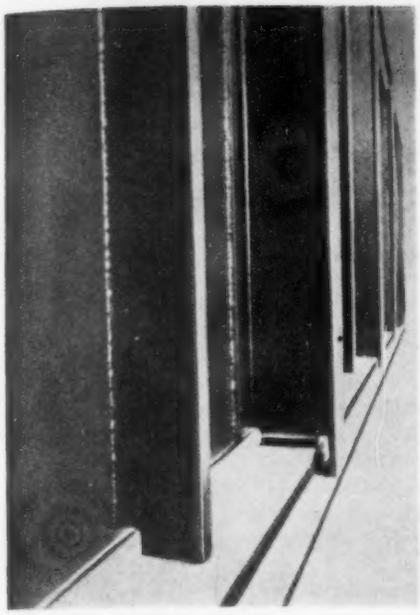


Fig. 3—View of Web Flange, and Stiffeners of Girder in Rüdersdorf Bridge

On the other hand, the cracks in the Rüdersdorf bridge, one of which occurred two hours after the other, did not show temper colors, but occurred during a cold night. The cracks seemed to start at a weld, Fig. 2, but spread several feet into the web of the plate girder. Examination revealed a slight lack of penetration at the middle of the X weld, which was insufficient to account for the crack, particularly in the absence of fatigue. Calculation and measurement showed that stresses due to the more rapid cooling of the steel work compared with the concrete road bed could not have caused the crack. The temperature stress could have amounted to not more than 5200 lb./in.², which raised the total stress to 22,700 lb./in.² Furthermore, the composition (0.20 C, 0.59 Si, 1.0 Mn, 0.06 P, 0.02 S, 0.03 Cr, 0.03 Ni, 0.34 Cu) and mechanical properties (tensile strength = 82,500 lb./in.², yield strength = 50,000–55,000 lb./in.², 24–30% elongation in 4 inches, notch-impact value = 8–12 mkg./cm.² longitudinal, 4–6 mkg./cm.² transverse, bend angle = 180° without cracks on tension side) of the steel were satisfactory. It is true that the welds were made in winter and the heat-affected zone was hardened (corresponding to a tensile strength of 114,000 lb./in.²), but bend specimens (1.0–1.2 inches thick) of welds cut from the Rüdersdorf bridge showed surprising ductility: 55° bend before the first crack occurred, 89° at failure.

It was believed, therefore, that the brittle fracture in the bridge might be ascribed to multi-axial stresses. It had been found that the bend ductility of a welded specimen may be greatly influenced by shrinkage stresses, and the specimens cut from the bridge were cut loose, at the same time, from a system of shrinkage stresses that may have been multi-axial. In order to secure a qualitative conception of the stresses in the plate girders, the stiffeners, Fig. 3, were sawn in two, Fig. 4. In fabrication the stiffeners had been welded to the web plate before the web had been welded to the ribbed flange. The dotted lines in Fig. 4 showed that the flange bowed 0.06 inch (the depth of the girder was 10 ft.)

DISCUSSION ON MULTI-AXIAL STRESS

If σ_z represents pure tensile stress,[1] the line OM in Fig. 5 schematically represents a stress-strain curve. If, perpendicular to σ_z other tensile stresses $\sigma_{x_1} = {}^1/_4\,\sigma_z$, $\sigma_{x_2} = {}^1/_2\,\sigma_z$, and $\sigma_{x_3} = {}^3/_4\,\sigma_z$ are imposed successively, the corresponding stress-strain curves are OM_1, OM_2 and OM_3. The more closely σ_x approaches σ_z, the less deformation is exhibited before fracture.

Shear stresses likewise change. If stress acts in only one direction, Fig. 6, as in the ordinary tension test to the stage at which necking occurs, the maximum shear stress τ is one-half the tensile stress σ_z. If, however, tensile stress acts in three orthogonal directions, the same tensile stress σ_z corresponds to a smaller shear stress. The more nearly the principal stresses σ_x and σ_z approach each other, the greater is the stiffening and the higher must be the tensile stresses in order to overcome resistance to slip. Should the stress locally exceed the cohesive strength (resistance to normal stress), a crack occurs, which is propagated as a brittle fracture, provided the yield strength in shear has not been exceeded.

Siebel and Maier[2] found experimentally that the capacity for deformation of tubes subjected simultaneously to axial tension and internal, hydrostatic pressure decreased as the axial tensile stress approached the tensile stress caused by the internal pressure. Calculation showed that the maximum tensile stress in the weld joining the web to the tension flange due to a fall in

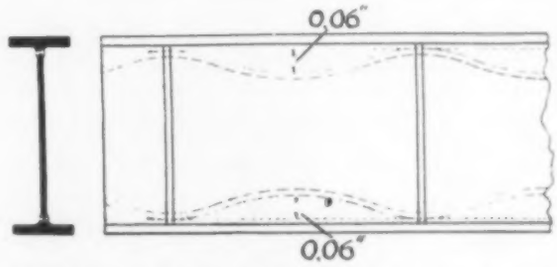


Fig. 4—Distortion of Flange After Stiffener Had Been Cut in Two

temperature of 10° C. and to the weight of the bridge was 22,700 lb./in.²

After the stiffener had been cut along section a-a, Fig. 7, the flange curved upward 0.06 inch. If the stiffeners had not been present, the flange would have distorted as in Fig. 8. The stiffeners prevented the distortion and created tensile stress at B, which can be calculated from:

$$\sigma = M/W$$
$$W = 2I/3.9$$
$$M = WL$$

$\Delta = 0.06$ inch $= WL^3/3EI$, if it is assumed that the stiffener acts at the edge of the flange. The tensile stress in the weld caused by the stiffener is thus about 25,600 lb./in.² The shrinkage stress is of about the same magnitude as the service stress and is perpendicular thereto.

According to Siebel and Maier, a rectangular specimen of mild steel attains a deformation at fracture in the ordinary, uni-axial tension test of 93%. In a test in which bi-axial tensile stresses of equal magnitude are imposed on the specimen the capacity for deformation is reduced to 12 to 15%. Similar results were obtained with medium carbon steel. Although Siebel and Maier's experiments on thin tubes may not apply directly to the Rüdersdorf bridge, it seems not improbable that the

[1] In one of his articles (*Z. VDI*, 1927, p. 1536) Ludwik asks, "Is it possible that a material exhibiting great ductility in the ordinary tension test may behave as a brittle material under tri-axial tensile stess?"

[2] *Z. VDI*, 1933, p. 1346.

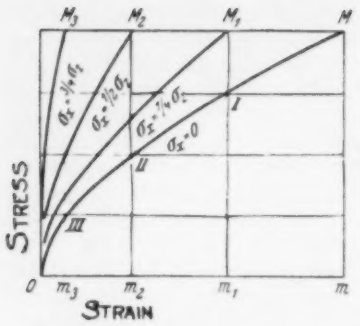


Fig. 5—Schematic Diagram Showing Effect of Polyaxial Stress Systems on Stress-Strain Curves (Ludwik)

cracks in the bridge were caused by the bi-axial stresses caused by the stiffeners. However, laboratory tests duplicating the conditions in the bridge have not been successful in securing brittle fractures. Perhaps shrinkage stresses in the butt welding of the web plates may have affected conditions. Tests designed to explain the Rüdersdorf cracks are being continued.

The following rules are important:

1. The steel must be as insensitive as possible to the heat of welding. The bead bend specimen (8 × 2 inches) must not fail in a brittle fashion and must yield over 20° bend angle before the first crack, even at −20° C. Open-hearth steel must be used, especially for flange plates. Tests should be made to determine whether steel over 1.18 inches thick should be normalized before welding.
2. The composition of deposited metal must be determined to guard against possible sulphur pick-up from the coating.
3. Flange plates over 2 inches thick should not be used.
4. The weld joining web with flange should be as near as possible to the neutral axis of the girder to obtain the least quenching effect. A T-shaped flange, therefore, should be used.
5. Small equalizing plates at least 1.18 inches thick should be placed between the stiffener and the flange, and may be welded only to the stiffener.

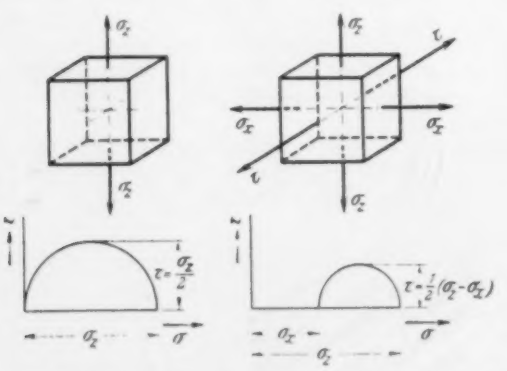


Fig. 6—(Left) Uni-Axial Stress System. (Right) Polyaxial Stress System

6. Welding operations should be protected from draughts and cold. The welding scarves of sections over 1.18 inches thick should be preheated to 200–300° C.
7. Electrodes should not be too thin in order that the heat effect should not be severe. The use of a thin electrode to weld the root of an X weld is not good practice, because the root layer is chipped out in any case.
8. The time occupied in changing electrodes should be as short as possible; otherwise the starting point should be heated before applying the next electrode.
9. Patching of defects in base metal must be forbidden.
10. Spatter on base metal should be removed and the affected parts should be heated locally.
11. Welded structures in which there are sections over 1.18 inches thick should be thoroughly proof tested before being placed in service.

As a result of discussion with experts of the German Iron and Steel Association, the German Structural Steel Bureau concluded that:

1. Low-alloy steel St 52 must be fine grained, and must be subjected to a special refining treatment in the open-hearth furnace.
2. Bead bend specimens must not yield a brittle fracture.
3. All rolled sections over 1.18 inches thick must be normalized.

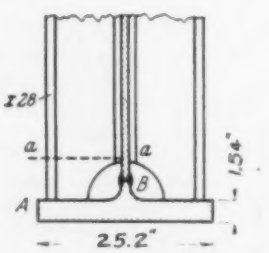


Fig. 7—Welded Plate Girder with Ribbed Flange and with Stiffeners Welded to the Web. The Stiffener Is Half of an I Beam: Flange Width = 4.7 Inches. Section *a-a*: Location of Saw Cut

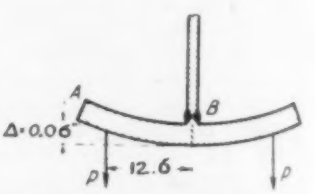


Fig. 8—Loads Exerted by Stiffener After Flange Had Been Welded to Web

4. Normalizing may not be necessary for special T-shaped sections up to 1.58 inches thick.
5. Rolled sections over 2 inches thick should not be used for the time being.

The following conclusions apply to mild steel St 37 for bridges and other important structures:

1. Welded mild steel bridges must be made of killed steel; rolled sections over 2 inches thick should not be used.
2. For other important structures killed steel should be used if the sections are over 1.18 inches thick; rolled sections over 2 inches thick should not be used.

WELDING VERSUS PREJUDICE

By J. F. LINCOLN*

THE welding industry is suffering from too many parents. Each parent wants to make the rules of conduct. The difficulty is that no two parents agree on how to raise the child.

Many people are attempting to make standards for welding without sufficient knowledge of the facts. Many people also are sure of a great many facts about the subject, the only difficulty being that these facts are just not so.

That welding has lived through its childhood under these conditions and grown to manhood is remarkable and shows how strong is its constitution.

Welding must have parents but there should not be so much doubt thrown on its paternity. Standards of conduct are necessary but they must be founded on fact and need.

There is no doubt that a great deal of the work which has been done to perfect and test welding, has been helpful. It is necessary, however, that any standards be founded on fact rather than fiction. The following facts learned from experience are true:

1. The shielded arc deposited metal is definitely stronger than mild steel plate under all conditions.
2. The shielded arc weld metal is a good deal more homogeneous than mild steel plate, hence less apt to defect.
3. The making of a weld with the shielded arc requires very little skill, particularly in the downhand position. The chance of that weld metal being as good as the parent metal is tremendously better than the chance of the parent metal being as good as the weld.

In spite of these facts we still have any number of people in positions of authority who insist on limitations, which are neither necessary nor intelligent. For instance, the Interstate Commerce Commission insists that to weld a tank car which carries liquids at no pressure, is dangerous. The fact that the tanks into which the oil goes from these tank cars must be welded to remove the chance of leakage, does not effect them. The further fact that this oil was distilled at a pressure of over 1000 lb. per square inch at over 1000° F. temperature, in an arc-welded vessel, disturbs them not at all.

The Interstate Commerce Commission still insists that a locomotive boiler cannot be welded although the locomotive superheater which carries the same steam pressure at a higher temperature in the same boiler, must be welded.

Authorities still insist that the skin of a ship shall not be welded in spite of the fact that the boilers inside the ship, carrying very high pressures, are welded. They still insist that many pressure vessels must be riveted because of the danger to life and yet 30 million automobiles in this country depend for their success on untested welds. The failure of any automobile weld would result in much greater loss of life than would be true of failure of many pressure vessels. In spite of all these facts welding is condemned or so restricted as to eliminate its economies.

This condition is not unusual. Perhaps because welding is a new industry the added care which these frequently silly requirements enforce is in the right direction, but unless this insanity is stopped at some reasonable point, the cost of fabrication will be unnecessarily and unduly increased.

The statement is often made that welding is all right provided the man who does the work is sufficiently skilled and careful. In many cases the operator must be tested every few months, or even days, in order to satisfy the inspector. It is doubtful if this is necessary. It is probably a good deal more difficult to make a weld which is worse than the parent metal than it is to make one which is better. With proper electrode, proper size and type of welding machine, and proper oversight by the foreman, it is a practical impossibility for any weld to be made which will not be better and more reliable than the metal itself. This is information which many people will question. In order to test the facts in connection with this matter the following test was made:

Fourteen men in the class of the welding school of The Lincoln Electric Company, entered on March 27, 1939, who had never had any welding experience whatsoever, were selected for the following test: (These were followed by an equal number two weeks later for the same test).

Plates to be welded were properly prepared. The welding machine was properly set and the proper size of electrode was given to the operator. He was given fifteen minutes' instruction in holding the arc. He then proceeded to make a standard test sample of all deposited metal of $^1/_2$ inch diameter and a length of something more than 2 inches, with two ends arranged for clamping in a standard tension machine. At the end of two weeks he made another sample in exactly the same way, and at the end of his course, i.e., four weeks, he made the third sample. The results given on the following page speak for themselves:

The following conclusions can be drawn from these facts:

1. These welds made by novices who had never had any experience before would have withstood all commercial requirements.
2. A very wide variation occurs in these tests. These are caused largely by the impurities in the plate being carried over into the deposited metal, not by difference in skill.
3. The weld metal is under all conditions better than the parent plate.

We can be assured from these tests that there is no reason for many of the tests now required. With proper type and setting of machines, proper size of electrodes, and proper visual inspection of the weld after completion, satisfactory welding can be done regardless of the training of the operator.

If other investigation or testing is to be done to assure the reliability of any welded structure, the plate should be the thing examined more than the weld.

* President, The Lincoln Electric Company, Cleveland, Ohio.

Class of March 27, 1939

A.M. Class

Operator's Mark	1st Week Tensile Strength	1st Week Elongation	2nd Week Tensile Strength	2nd Week Elongation	4th Week Tensile Strength	4th Week Elongation
SG-5	66,500	31	65,800	38	66,000	21.5
RH-5	70,000	23	66,500	25.5	56,800	14.5
JH-5	65,000	16.5	63,900	15.5	67,800	30
PJ-5	65,200	19	67,300	27	67,800	31
VL-5	50,700	12.5	65,400	20	64,400	23
AL-5	66,800	17	63,200	21.5	68,800	34.5
EN-5	69,500	18.5	67,000	18.5	67,500	32
BP-5	69,600	27	67,300	30	63,900	30
ES-5	68,300	22.5	63,400	29.5	65,200	32
TS-5	72,100	13	64,200	30	64,900	30
JV-5	70,300	23.5	64,700	24.5	65,200	29
LW-5	65,200	18.5	64,700	16	65,200	27
CW-5	65,000	11	66,800	19	67,500	31
HD-5	64,700	23	62,400	15.5	66,800	32.5
Average	66,350	19.7%	65,185	23.6%	65,557	28.4%
			P.M. Class			
BA-9	63,700	32	68,000	33.5	63,700	28.5
AB-9	66,800	23	69,300	30	68,000	32.5
EB-9	64,200	32	62,700	34	62,900	31
WB-9	69,800	27.5	65,200	38	62,900	35
JB-9	70,800	31.5	67,300	32	64,200	35
FE-9	67,300	27	67,800	29	63,700	31
EH-9	67,500	30	67,800	30.5	62,700	33
JH-9	73,400	25	63,200	32	60,600	29
IK-9	66,500	28	69,300	27	60,600	36
HM-9	64,400	33	66,200	29	61,700	37.5
FM-9	68,300	21	65,200	27	63,700	29
RN-9	62,200	32	63,400	32.5	61,900	37
SR-9	68,800	26	66,500	27	66,200	30
JS-9	51,700	9	65,800	23.5	64,700	27.5
Average	66,100	27.2%	66,264	30%	63,392	32.2%

Class of April 3, 1939

A.M. Class

Operator's Mark	1st Week Tensile Strength	1st Week Elongation	2nd Week Tensile Strength	2nd Week Elongation	4th Week Tensile Strength	4th Week Elongation
CB-5	67,500	28	71,800	26	62,700	33.5
ED-5	66,200	14	63,700	18	64,900	29
LC-5	61,900	13	62,700	13.5	65,200	20.5
EF-5	71,800	30.5	63,900	28	66,800	24
AG-5	65,500	19	70,800	22	62,700	20
TG-5	70,100	20.5	63,200	20	62,200	27.5
JH-5	65,500	30.5	65,800	17.5	61,900	17.5
CK-5	67,500	30	67,000	25	64,900	32.5
JP-5	68,000	22	63,200	20	61,900	27
JR-5	68,500	29.5	68,800	20.5	64,400	25
AS-5	64,700	29	66,800	19	62,200	30
IS-5	68,000	17.5	64,700	22	63,200	31
TT-5	64,400	29				
CW-	65,900	21.5	65,900	25.5	62,700	25.5
Average	66,821	23.9%	65,185	23.6%	63,515	27%
			P.M. Class			
RB-9	64,200	33	65,200	33.5	67,000	29.5
WC-9	62,900	34	62,700	29.5	59,400	31
CC-9	67,800	30.5	62,400	34	61,700	27
MF-9	64,400	30	64,700	35	59,900	30.5
JG-9	61,700	35	59,100	33	67,300	33.5
RH-9	65,700	33.5	63,400	35		
EJ-9	63,700	33.5	63,100	23.5	62,900	31
GJ-9	63,900	30	62,700	33.5	65,900	23.5
LM-9	64,200	34	65,800	29.5	65,900	24
FN-9	63,200	34	65,200	36	64,200	23.5
LR-9	73,900	28	66,300	37		
JS-9	67,800	24	68,300	26	66,800	28
WT-9	65,200	34	69,500	31.5	63,700	26
GW-9	65,200	34	61,700	30	61,100	36.5
WY-9	61,700	36	62,200	35	61,900	35
PZ-9	66,800	23.5	64,700	34	59,900	35
Average	65,144	31.7%	66,264	30%	63,400	29.6%

FUNDAMENTAL NATURE of WELDING

I. The Effects of Heating Velocities, Carbide Diffusion and Carbide Melting in Electric Spot, Flash and Resistance Welding

By DONALD E. BABCOCK*

AMONG the various processes such as spot, resistance flash and welding, there should be certain very fundamental chemical and metallurgical effects which could readily be interpreted or predicted from equilibrium data, if the proper application of diffusion kinetics were applied to the welding process in conjunction with the chemical equilibrium restrictions. This brings to the front the one point of particular interest in these considerations, and that is the time factor. The time element is of major importance.

An equilibrium diagram, such as is given herein for the carbon-iron alloys, is simply a graphic representation of the distribution of the various components making up this system when no further change will occur for a given set of conditions of temperature, pressure and composition, or other variables. It is safely assumed, for the purposes of this study, that the carbon-iron diagram accurately describes this system in detail. Since equilibrium conditions are the end product or final product distribution which resulted from a kinetic process, it is a state toward which a system tends to move, but seldom, if ever, finally reaches. Since reaction kinetics and diffusion are the means of reaching equilibrium, they must be considered when any variations in the normal conditions occur such as may result from rapid heating and temperature variations in welding.

* Industrial Fellow, Mellon Institute, Pittsburgh, Pa.

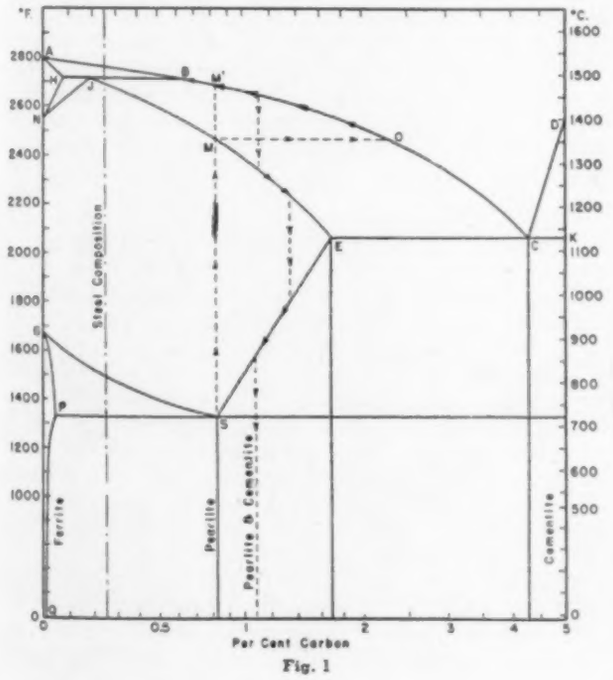


Fig. 1

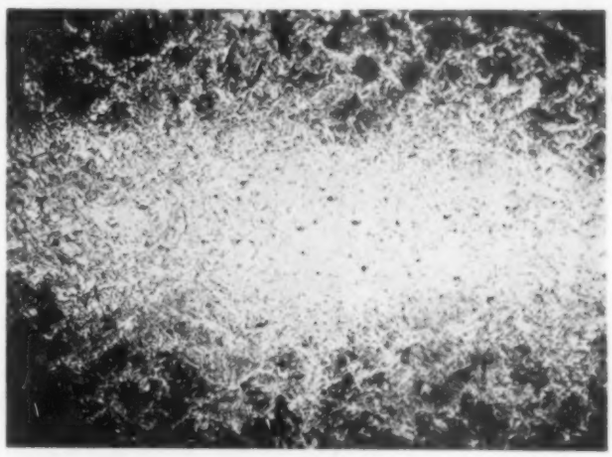


Fig. 2—Magnification 100 X

In order to fully consider this problem involved in welding, due consideration must be given to the fact that these iron-carbon alloys are two-phased systems at low temperatures, namely ferrite and a carbide rich phase which may be either cementite or pearlite. Carbides in the form of pearlite are 0.83 to 0.87% carbon, and because of the fine state of carbide subdivision should be rapidly transformable into austenite of the same composition. If this austenite were to be heated to a temperature of about 2460° F. (1350° C.) the first liquid would begin to sweat out of this structure and would have the composition as indicated by the point *O* (2.3% C.) on the liquidus line *ABC* in the diagram (Fig. 1). As the temperature is increased, the composition of the liquid would change, moving through points of progressively lower carbon composition until the liquid would be of the same composition as the austenite, namely, 0.87% carbon, at which point the last trace of the carbon-rich austenite would disappear. We may then say, for convenience, that this point is the melting point of the pearlite phase which is a temperature of 2680° F. (1470° C.). Carbide-rich austenites of the same composition as pearlite melt or are completely melted at temperatures of approximately 120° F. (66° C.) below the melting point of pure ferrite or delta iron. It is also important that the carbide solid solutions in austenite melt incongruently, giving liquids richer in carbon content than their solid solutions.

Since the low carbon steels, at temperatures below 1333° F. (723° C.), consist of varying amounts of fer-

rite and pearlite, depending on their carbon content, and very rapid heating of such a two-phased system, will raise the temperature of these two phases to the melting points of the lowest melting one before it could be normally resorbed or dispersed into the more uniformly carbide-rich austenitic structures as required by purely equilibrium conditions. Such melting effects in the metal matrix would produce a condition which may be likened unto a ferrite sponge, the interstices of which are filled with a carbon-rich liquid. When such a spongy matrix is upset or compressed during welding by the applied pressure, the liquids present will be squeezed out and a ferritic area of reduced carbon content produced without the aid of any oxidation whatsoever.

CARBIDE MELTING EFFECTS

An examination of the equilibrium diagram in a more detailed manner will serve to clarify this discussion of the melting as it occurs during welding. Let us take for example the welding of a sample of steel containing 0.25% carbon as indicated on the diagram by the line marked "Steel Composition." The composition of the steel under equilibrium conditions should completely control the changes which can occur in the system as the temperature is raised, and it would, were it not for the interference of diffusion kinetics which require time to bring about equilibrium conditions. As this steel, which consists of about 30% pearlite and 70% ferrite, is rapidly heated in the electric resistance or spot welding process, melting temperatures of both phases are rapidly approached. The pearlite, which rapidly is converted to austenite of the same composition, is quickly raised to the point M on the solidus line JME where a liquid of the composition represented by the point O begins to sweat out of these pearlite or austenitic areas. The compositions of this liquid would change rapidly from point O on the liquidus line ABC toward, and somewhat beyond M', where all of the carbide-rich austenitic phase would be melted. Squeezing of these welding surfaces under pressure would drive out this carbon-rich liquid.

During this heating of these welding surfaces and pearlite melting, carbon diffusion has been occurring which tended to aid the melting of the ferrite, which should, according to the equilibrium diagram, have passed through the austenite transformation and then from the austenite to delta iron. As the temperatures are raised to above 2555° F. (1400° C.), the solubility of the carbon in the delta iron increases to a limit of 0.08% (point J) of carbon at a temperature of 2715° F. (1490° C.) where, for further increase in the temperature, the carbon solubility in delta iron is reduced. At this temperature of 2715° F., this maximum carbon content of 0.08% in delta iron is in normal equilibrium with a liquid containing 0.55% of carbon, which means that any further influx of carbon is impossible because of the saturation of the crystal. Thus, a low carbon solid matrix is established so long as these or higher temperatures are maintained.

When this system is allowed to cool, the reverse of these processes will occur. The relatively slow replacement of the carbon by its diffusion from the portions of the metal richer in carbon would not in the time available re-establish the normal carbon content in the welded surfaces.

Of interest to us further in the pursuit of these considerations is the condition which arises from the extrusion of these carbide-rich liquids into the cooler portions of the metal matrix. This result of cooling such carbon-rich liquid may be predicted if it be assumed that before the entire portion of the carbide-rich areas had been melted, the liquid melt of a composition between M' and O were quickly cooled to form a solid of a carbon composition greater than that found in pearlite. The cooling of such liquids through the austenite transformation would result in the segregation of cementite in a system where equilibrium conditions strictly forbid the presence of cementite as a component part of the equilibrium. This is entirely due to the diffusion kinetics that such conditions are possible.

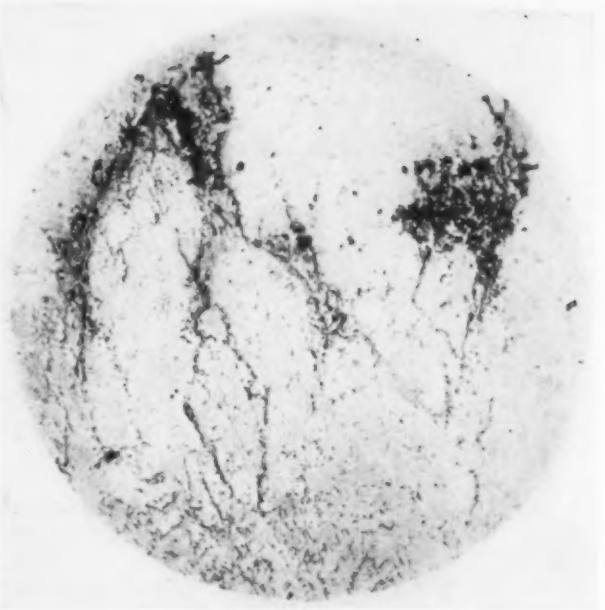


Fig. 3—100 ×

For proof of this carbide melting condition, it was necessary to show both the photomicrographs of the welds under discussion and of the entrapped carbide-rich segregates. Figure 2 shows the weld line under consideration, and is of the type typical of resistance butt or flash welding. Figure 3 shows the entrapped segregate etched with sodium picrate to darken the cementite which was being extruded from the structures by the forging pressures applied. The absence of normal pearlite is apparent and the areas surrounding this segregate are low in carbon. This type of structure is somewhat rare and not commonly associated with the usual welding practices which produce welds free from brittleness.

CHEMICAL PROOF OF WELD COMPOSITION

It has been pointed out on purely theoretical principles that the weld line structure in Fig. 2 is ferritic and low in carbon content. This conclusion was arrived at by both metallographic studies and corrosion properties. The samples which could be obtained from such small structures were themselves so small that micro methods had to be employed. This was done.

Test samples from such a weld were taken each 0.005 inch, and analyzed by color carbon methods and compared against standards as well as the main body of the metal. The results are tabulated as follows:

Of the above data, the lowest boundary value is that which was accepted as being the actual weld line composition in this case. These results which have been subsequently redetermined by other microchemical

Table 1

Position	% Carbon Found	
R 0.100 in.	0.23–0.23	
R 0.075	0.23–0.24	
R 0.050	0.22–0.25	
R 0.025	0.20–0.25	
R 0.010	0.12–0.23	
0.000	0.07–0.14	Weld area mainly
L 0.010	0.15–0.25	
L 0.025	0.18–0.25	
L 0.050	0.23–0.24	

means show conclusively the decarburized nature of the welding surfaces at their point of welding. (Oxygen analyses showed that actual deoxidation had occurred during welding. This result was expected from the previous discussions.)

The basic principle of these discussions may well be applied to the welding of other metals than the steel discussed in this short paper. The same conditions would apply to other two-phased systems or more, as the case may be. The phenomenon of diffusion kinetics will account for the variations in the hardening of the welded zones in both spot, flash and resistance welding and the structures and strengths developed in the joints. These discussions will be given at a later date.

GREETINGS OF THE BOILER CODE Committee*

By D. S. JACOBUS†

IT IS indeed a pleasure to meet you all again and extend the greetings of the Boiler Code Committee. Your organization is working hand in hand with the Boiler Code Committee. The cooperation of the two groups is well recognized and is brought out in the foreword of the Power Boiler Code, which reads in part as follows:

"The National Board of Boiler and Pressure Vessel Inspectors is composed of chief inspectors of states and municipalities that have adopted the Boiler Code. This Board, since its organization in 1921, has functioned to uniformly administer and enforce the rules of the Boiler Code. The cooperation of that organization with the Boiler Code Committee has been extremely helpful. Its function is clearly recognized and, as a result, inquiries received which bear on the administration or application of the rules are referred directly to the National Board. Such handling of this type of inquiries not only simplifies the work of the Boiler Code Committee, but action on the problem for the inquirer is thereby expedited. Where an inquiry is not clearly an interpretation of the rules, nor a problem of application or administration, it may be considered both by the Boiler Code Committee and the National Board."

We have worked together since your organization and up to date all final actions on matters which have come before the Boiler Code Committee have been unanimous. It would have been impossible to work in this harmonious way had it not been for the mutual friendship which exists and the willingness of those who take part to consider the viewpoint of the others. It is hoped that it may be possible to continue this unanimous action even though the work has been broadened by including many additional elements.

In reviewing the work of the past it is clearly evident that the spirit which pervades the work of the Boiler Code Committee has much to do with its success.

The efforts to remove John Stevens from the chairmanship of the Committee did much to promote close friendship between the members. Stevens was accused of many things by his enemies in the early formation of the Code, but not once of dishonesty. The Committee fought to a man for his retention and a spirit of loyalty was engendered which has continued to the present day.

Fred Low, the second chairman of the Committee, was beloved by all on account of his kindliness and keen insight into human nature which, coupled with his sound engineering judgment, made him an ideal guide for the Committee. Throughout his illness he asked many times about the doings of the Committee and in his last spell of consciousness a day or so before he died he requested me to remember him to the boys on the Committee, who he said were "a great bunch."

Such is the spirit of loyalty which, coupled with the guidance and backing of our parent organization, the American Society of Mechanical Engineers, and the cooperation of many other groups and interested parties, has led to the success of our work.

The cooperation of the steel-making industry and the A. S. T. M., and many manufacturers and experts was secured in preparing the first Code and this has continued up to the present time.

There has been full and complete cooperation between the AMERICAN WELDING SOCIETY and the Boiler Code Committee on all matters bearing on welding. The use of fusion welding has advanced rapidly but there are many problems still to be solved. This is brought out clearly in the work of the Special Committee on Extension of Fusion Welding Requirements, which has prepared rules for broadening the field of application of welding and has worked with other committees to simplify the rules for qualification of welding processes and for testing welding operators. It is proposed to replace the corresponding rules now in the Code with the new rules to make them uniform, which will do much to simplify procedure.

All the other Subcommittees and Special Committees of the Boiler Code Committee have done excellent work. The Special Committee on Alloyed and High Tensile Steels for Welded Pressure Vessels and on Approval of New Materials has assisted the Boiler Code Committee in assigning the various uses to which materials may be put. The Subcommittees on Ferrous and Non-Ferrous Materials have established the allowable working stresses for different temperatures. The Special Committee on

* Address at meeting of National Board of Boiler and Pressure Vessel Inspectors Convention in New York City, May 15, 1939.

† Advisory Engineer, The Babcock and Wilcox Company, New York.

Clad Vessels has been active in establishing rules bearing on the construction and use of such vessels.

The Special Committee on Safety Valve Requirements has prepared revisions which were adopted covering testing and stamping of safety valves and has completed a painstaking investigation and prepared a revised table of minimum areas of openings in fire tube boilers for safety valve connections.

The Subcommittee on Welding has been particularly active, as well as the Subcommittee on Special Design. The Subcommittee on Material Specifications has had a busy year. All this work has thrown considerable labor on the Special Committee on Coordination, the duty of which is to coordinate all of the different rules. The past year has certainly been a most active one, and has called for a vast amount of time and effort from the members of the Boiler Code Committee and those who cooperate in the work.

As you know, the members of the Boiler Code Committee act in their individual capacities and not as representatives of any organization or industry, but this does not interfere with the Committee cooperating as a whole with other groups and organizations. Three organizations have appointed Conference Committees for assisting in the work of the Boiler Code Committee, these being The American Society for Testing Materials, The American Association of Steel Manufacturers and the AMERICAN WELDING SOCIETY. A movement is now under way to reorganize the work of the Boiler Code Committee and the question of additional conference committees, subcommittees and special committees, as well as the personnel of these committees will receive most careful consideration.

Progress is being made in revising Section VIII to include certain provisions of the A. P. I.-A. S. M. E. Code and to prepare a code for unfired pressure vessels which will be applicable to the different industries. The first section of the revised Code is on General Requirements for All Types of Vessels, and the second on Requirements for Fusion Welded Vessels. Proposed revisions of these two sections were sent to the members of the Special Committee about three weeks ago and the remaining sections will be forwarded within a few days, so that the foundation on which to build any further additions that may be deemed necessary will soon be completely in the hands of the Special Committee. It is proposed to hold another meeting of the Special Committee within a comparatively short time with a view of making definite progress toward the completion of the draft. After the draft is completed it is proposed to publish it in proof form and to forward copies to interested parties, and to hold public hearings if considered necessary.

The revision of Section VIII will no doubt tend toward its universal use by those states that have adopted the Power Boiler Code. It will be of great importance in connection with the Unfired Pressure Vessel Code to continue the cooperation that has been secured from the petroleum, chemical, refrigerating, compressed gas and other industries.

An agreement was finally reached respecting the gages of tubes for water-tube boilers and a table and formulas were published in *Mechanical Engineering* with the request that criticisms or suggestions be submitted to the Boiler Code Committee. So far no criticisms have been received, and it is hoped that the proposed table and formulas for wall thicknesses for different pressures will be acceptable.

It is interesting to note that features which have been discussed in the past again come before the Boiler Code Committee. In the preparation of the first Code there was much discussion on how far it should go into details. It was finally agreed that the fundamental features should be covered, leaving a number of details to the judgment of the designer and the inspectors. As time went on questions that were asked and replied to in the form of interpretations were embodied in the Code and many details were added. We should make sure that we do not interfere with the clarity of the Code by going too far in this direction.

In the older as well as in the present rules the ductility of the material is an important element as the strains in any overstressed part are reduced through the elongation of the material when the yield point is exceeded and this tends to equalize the stresses. The ideal way would be to employ a construction which would avoid or minimize stress concentration. With a structure so designed as to avoid undue stress concentration at any point it would be feasible to base the working stresses on the yield strength rather than on the ultimate strength of the material and allow higher working stresses for some grades of material than when they are based on the ultimate strength. This brings up a question that was thoroughly discussed in the formulation of the first Code, when there was a movement on the part of some to base the allowable working stresses on what was then known as the elastic limit rather than on the ultimate strength. This question has been raised again in connection with new materials that are now being considered by the Committee and it is mentioned at this time to show the breadth of the work still before the Boiler Code Committee.

We should remember that the Boiler Code Committee was established to formulate Standard Specifications for the Construction of Steam Boilers and other Pressure Vessels and for Their Care in Service. The Committee was instructed to consider the views of the manufacturers and the users as well as the scientific features of the problem. In all of the work it receives substantial aid from the National Board of Boiler and Pressure Vessel Inspectors. As I have said on many previous occasions, it is hoped that our two organizations may continue to appreciate the necessity of cooperating to the fullest extent with each other and that this cooperation and the spirit of mutual dependence and trust may be continued for many years to come.

SETS OF BOUND VOLUMES OF JOURNAL

In order to provide some of the new members of the Society with an opportunity to complete their library on Current Welding Literature, the AMERICAN WELDING SOCIETY is offering to these new members an opportunity to purchase the last nine bound volumes for the years 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938 at $5.00 each and $40.00 a set. The price to non-members for individual volumes is $6.50 and for the set $45.00. Postage extra.

Each bound volume contains a Subject and Authors' Index and is bound in attractive imitation black leather covers. The set probably includes the most important welding information available in the literature.

Welding Society ACTIVITIES—Related Events

INSTITUTION OF MECHANICAL ENGINEERS OF GREAT BRITAIN TO MEET WITH A. S. M. E., SEPT. 4-8, 1939

For the first time in thirty-five years, except for a short visit in 1932, The Institution of Mechanical Engineers of Great Britain is coming to the United States this fall, Sept. 4th to 8th, to meet with The American Society of Mechanical Engineers. As in 1904, at the time of the St. Louis Exposition, the World's Fair in New York is providing an interesting background for this joint gathering. Our British guests will also visit Boston, Toronto, Detroit, Cincinnati, White Sulphur Springs, Washington, and Philadelphia.

At the time of the New York meeting the two societies of mechanical engineers will be joined by the Institution of Civil Engineers and the Engineering Institute of Canada who are meeting with the American Society of Civil Engineers. Both British groups will come from England on the *Samaria* and arrive on Sept. 3rd in Boston where they will be greeted by the Boston Committee. After luncheon and a sight-seeing trip, the party will entrain for New York for arrival in the evening. The mechanical engineers will be housed at the Hotel Pennsylvania, the civil engineers at Columbia University.

BALTIMORE GETS NEW WELDING CODE

The City of Baltimore, under the direction of John M. Russell, Building Construction Engineer and Secretary of The Building Code Committee has just completed a proposed draft of regulations for welding which will be presented to the Mayor and City Council in November of this year for approval, along with other regulations in the Main Building Code, thus placing structural welding on a par with other methods of construction.

"Tentative Rules for the Qualification of Welding Processes and Testing Operators" as formulated by the AMERICAN WELDING SOCIETY, June 1937, were adopted by the City for qualifying welders.

Welding knowledge and experience of various groups was drawn upon by the invited participation of the following representatives:

Van Ransselaer Saxe—Consulting Structural Engineer

H. N. Boetcher—Consolidated Gas and Electric Company

Basil Osmin—Welding Engineer, Maryland Casualty Company

J. H. Davis—American Iron and Steel Institute

J. C. Harris, Jr.—Consolidated Gas and Electric Company

J. A. Brown—Member of Building Code Sub-Committee

C. W. Patterson—Member of Building Code Sub-Committee

Several meetings were held at the City Hall before the final draft was decided upon.

As drafted "Welding Code" deals broadly with electric arc, gas, resistance welding and gas cutting and consists of ten individual paragraphs namely:

1. General Requirements for Welding and Cutting
2. Definitions for Welds
3. Butt Welds
4. Fillet Welds
5. Welded Girders
6. Welded Columns
7. Stresses Induced by Welded Connections
8. Qualification of Contractors and Operators for Fusion Welding
9. Supervision and Inspection of Fusion Welding
10. Resistance Welding

MINIMUM REQUIREMENTS FOR THE TRAINING OF WELDING OPERATORS IN TRADE SCHOOLS

At a recent meeting of the Board of Directors, the Committee on Outline of Work was authorized to appoint a committee on the above subject. Mr. A. B. Wrigley, State Supervisor of Trade and Industrial Education in New Jersey, was named as Chairman of this Committee.

FILLER METAL SPECIFICATIONS

On recommendation of Committee on Outline of Work, appointment of Major H. B. Vaughn, Jr., Chief, Marine Design Section, Office of the Chief of Engineers, War Department, as a member of the Filler Metal Specifications Committee was approved.

TRANSIT CONVENTION

Executives of street railways and bus companies from all over the United States and Canada will convene at the 58th annual convention of the American Transit Association, to be held in Los Angeles and San Francisco from August 9 to 16, 1939.

Delegates will meet in Los Angeles at the Hotel Biltmore from August 9th to August 12th. The convention will continue in San Francisco at the Hotel Fairmont and Hotel Mark Hopkins, from August 13th to 16th.

Participating in the convention will be the following affiliated A.T.A. organizations:

American Transit Accountants' Association

American Transit Association Bus Division

American Transit Claims Association

American Transit Engineering Association

American Transit Association Interurban Division

American Transit Operating Association

American Transit Purchases and Stores Association.

NOMINEES ELECTED

As a result of counting the ballots recently sent out in connection with the election of officers for 1939-1940, the following nominees will be formally inducted into office at the Annual Meeting of the Society in October of this year.

President—G. T. Horton

First Vice-President—T. C. Smith

Second Vice-President—L. S. Moisseiff.

District Vice-Presidents: New York and New England—W. F. Hess; Middle Eastern—L. C. Bibber; Middle Western—K. L. Hansen; Southern—A. J. Moses; Pacific Coast—L. W. Delhi

Directors-at-large—E. V. David, J. D. Gordon, G. F. Jenks and H. S. Smith.

The By-Laws provide that if no nominations, other than proposed by the Committee, are made by 25 qualified members, then the Secretary shall treat the nomination ballots as Election Ballots and certify the results to the Presiding Officer at the Annual Meeting.

WELDING MEETING

A meeting and exhibition of unusual interest was presented Tuesday evening, May 23rd, when the Western Kentucky Mining Institute met in the EMBA Hall in Earlington, Kentucky. This meeting was sponsored for the Institute by Mr. Frank H. Stanhope of the John W. Minton Welding Company at Madisonville, Kentucky.

Due to the general interest of some of the papers, the meeting was attended by a mixed group of men and women and a check of the registration indicated that over 650 people were present.

The complete program follows:

The Commercial Production of Oxygen, by Mr. A. H. Seese, CIG, Evansville, Indiana.

Demonstration of the Magic of Liquid Oxygen, by Mr. E. C. Mowrey, CIG, Evansville, Indiana.

Oxygen as Applied in the Medical Field, by Mr. P. G. Wesley.

Safety in Oxy-Acetylene Equipment, by Mr. R. G. Wilson, CIG, Chicago, Illinois.

Bronze Welding—When and Why, by Mr. J. F. Olsen, CIG, Chicago, Illinois.

Demonstration of Underwater Cutting, by Mr. Frank W. Stanhope, Minton Welding Company, Madisonville, Kentucky.

The attractive and comprehensive exhibits, of various manufacturers, attracted the members of the Institute and the general public. Exhibitors at this meeting were Chicago Pneumatic Tool Company, Una Welding, Inc., Compressed Industrial Gases, Inc. and the John W. Minton Welding Company.

DOUBLE, DOUBLE, TOIL AND TROUBLE; FIRE BURN AND CAULDRON BUBBLE . . .

—Macbeth

No, this is not a group of witches stirring their mysterious cauldron, but a group of mechanical doctors (arc welders) doing a major operation. Such operations are now as common in the industrial world as appendectomies are to the average person. This particular operation was to quickly restore a steel mill to service by repairing the pusher head of a scale breaker which is used to remove slag from slabs coming from the reheating furnace.

To repair the break which stopped an entire mill, 400 pounds of steel, in the

Photo courtesy The Lincoln Electric Company, Cleveland, Ohio

form of arc welding electrodes were melted into the casting. Without electric arc welding, the mill would have been shut down for several weeks awaiting a new casting. Six arc welders had the mill back in operation in eight hours.

LUKENS APPOINTS CURTISS GENERAL SUPERINTENDENT

Lester M. Curtiss, who has been Assistant General Superintendent of Lukens Steel Company, Coatesville, Pa., has been appointed General Superintendent in charge of all operations of the company, according to an announcement made by Robert W. Wolcott, President of the concern.

Mr. Curtiss succeeds G. Donald Spackman, who has been granted a leave of absence at his own request in the interest of his health. Mr. Spackman will continue to serve the company in an advisory capacity, and will resume active duty with Lukens when his health permits.

Mr. Curtiss was born in April 1893 at Norfolk, Conn., and attended public school and the Robbins School, later going to Wilson Military Academy at Somerville, New Jersey, preparatory to matriculation at Lafayette College, Easton, Pa. He was graduated from Lafayette in 1916 with the degree of Bachelor of Science in Chemistry.

In the same year, Mr. Curtiss joined Merck & Company at Rahway, New Jersey, serving in their chemical manufacturing department. In 1916, he joined Harrisons, Inc., Philadelphia, in the acid manufacturing department until August 1917. During the war, Mr. Curtiss served as first Lieutenant in the Field Artillery.

In 1919, Mr. Curtiss joined Lukens Steel Company as Assistant Engineer of Tests, holding that position until 1923 when he was made Engineer of Tests. In 1925, he was promoted to Assistant Superintendent of Plate Mills, and served in that capacity until 1928. He was then appointed Superintendent of the Lukens 140-inch mill and the Lukens 206-inch mill, the latter being the world's largest plate mill. In 1932, Mr. Curtiss was promoted to Superintendent of Plate Mills, in charge of all mills of the company. In October 1935, Mr. Curtiss was again promoted, to Superintendent of Production, in charge of all production facilities of the company, which position he retained until his elevation to Assistant General Superintendent in 1936.

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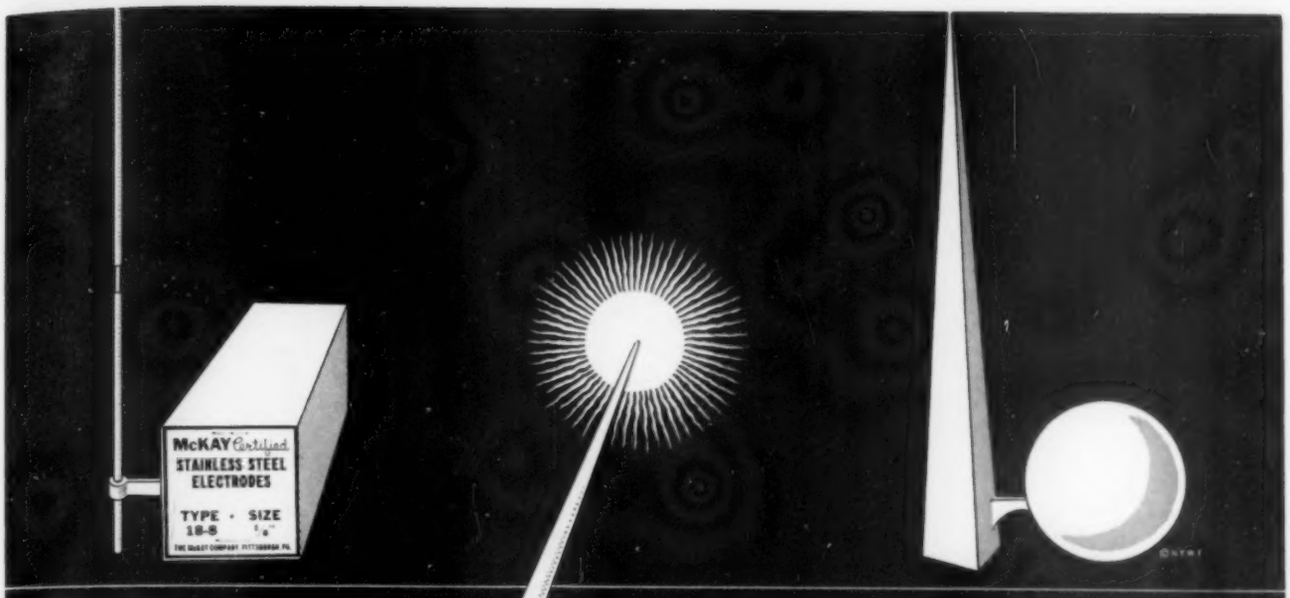

THE ROD OF TODAY *for* THE WORLD OF TOMORROW

McKay Certified Stainless Steel Electrodes have the following important operating characteristics—does the stainless electrode you are using now have them?

1. Certificate in every package that weld deposit will result in a balanced alloy of the analysis specified.
2. Instant contact upon restriking arc.
3. Easy slag removal.
4. Spatter-free within practical limits.
5. Smooth bead with perfect weld contour.
6. All alloys contained in core wire.

These qualities are unusual in a Stainless Electrode but McKay has them. A test on your own work will prove that you need McKay Certified Stainless Electrodes in Stainless Welding.

More detailed information is given in McKay Stainless Catalog, mailed on request.

THE McKAY COMPANY

Executive Offices, Pittsburgh, Pa.

SALES OFFICES, YORK, PA.

MANGANESE STEEL CATALOG

The American Manganese Steel Division, Chicago Heights, Illinois, has just issued a new 64-page catalog which contains over 400 illustrations showing Manganese Steel Castings for every industry using equipment, the parts of which are exposed to impact and abrasion.

Copies of this catalog may be had by writing the manufacturer.

FLAME DESCALING APPARATUS

Illustrated is the company's new Oxy-acetylene Descaling Apparatus recently developed to remove scale and other similar accumulations from iron and steel by rapidly heating such deposits with the multi-flame tips, thereby causing the cracking-off of the scale as a result of

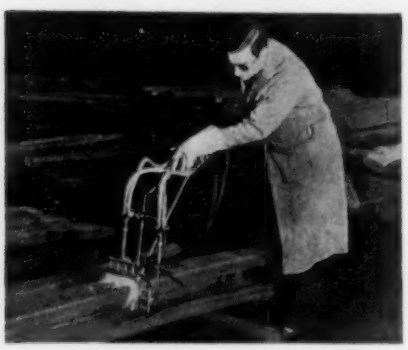

Photo courtesy Air Reduction Sales Co.

the differential expansion between the scale and the base metal. This process removes scale from ingots, billets and slabs to expose seams and defects for inspection prior to scarfing or chipping, from forgings and steel castings prior to machining and steel castings after annealing. Where necessary, the apparatus is mounted on wheeled carriages for ease in travel across steel surfaces.

INTERESTING REDESIGN

The accompanying illustration shows the latest model trailer manufactured by the Leeson Trailer Company, Tuscon, Arizona, which grew out of a study of redesign.

Formerly, the company made their frames from angles and channels bolted together. The floors and sides were of wood.

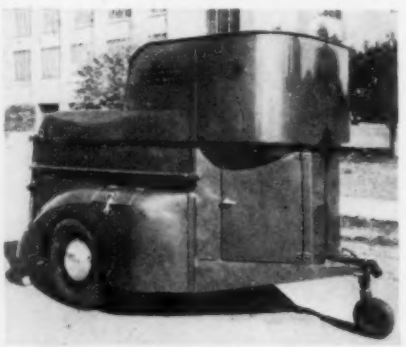

Photo courtesy The Lincoln Electric Company, Cleveland, Ohio

Following considerable study and experiment, which brought to light certain advantages to be obtained with welded construction, they changed their bolted frame design to one for welded construction. Just recently they went a step further and have worked out a complete design for all-welded steel construction. The illustration shows the fine appearance which resulted from the study.

Particular attention is called to the fenders. These are composed of seventeen separate pieces of steel welded together, after being pressed into shape in wooden forms by means of a hydraulic ram. This method makes it possible to produce the trailer with less than ten pounds of scrap loss since each piece of steel may readily be fitted into the construction.

Surprising as it may seem, this trailer, although much stronger and better looking than when produced with wood construction, actually costs 20% less. At the same time the manufacturer is able to sell the new product more readily at a 25% higher price. The unit illustrated sells for $850.00.

BIT MANUFACTURE DISCUSSED

The paper, "Some Defects Found in Hard-Faced Drilling Tools—and Their Remedies," presented by C. W. Metzger of Haynes Stellite Company at the Oil-World Exposition held in Houston, Texas, in April, has been issued in the form of a 20-page booklet. This paper, which was given at the meeting of the Drilling and Production Committee, is an intensive discussion of the subject. It describes a large number of cases and, by photomicrographs, illustrates most of the common bit defects. The text explains how to obtain the correct base metal structure, strong tungsten carbide insert-to-steel bonds and good tungsten carbide grain-to-steel bonds. The effect of dissolved tungsten carbide on the base steel is discussed in detail. The paper should be of value to all those interested in the manufacture of well drilling bits. Copies can be obtained from either Oil-World Exposition, Inc., Houston, Texas, or Haynes Stellite Company, Kokomo, Indiana.

A ONE-TON WELDED CROWN

An impressive tribute to Britain's rulers from one of Canada's great industries took the form of this enormous crown—later raised to the tower of a pulp and paper company in time for the royal

Photo courtesy The Linde Air Products Co.

SAVE MONEY... BY WELDING

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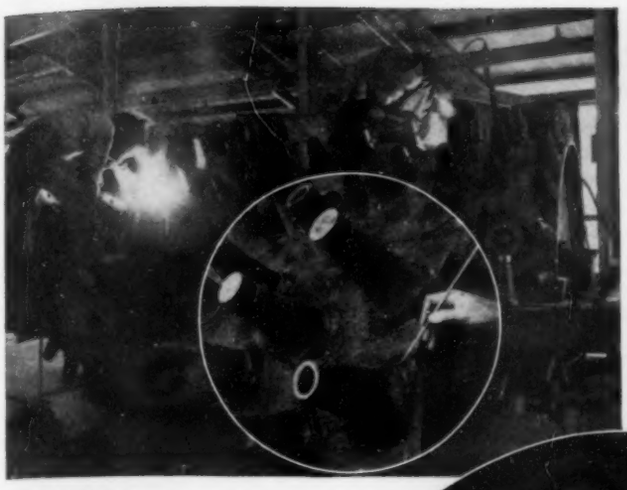
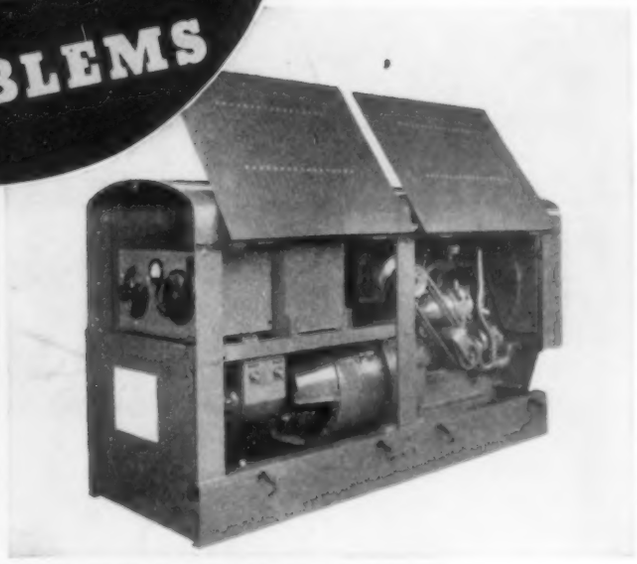


DAMS are built *quicker, at less cost* when Lincoln *"Shield-Arc"* Welding is on the job to repair and reclaim equipment such as this tamper. New steel feet are welded on as shown in the inset. Photos courtesy Pacific Constructors, Inc., at Shasta Dam.

WELDING SOFTENS THE WATER PROBLEMS

PIPE LINES such as this 51-inch line of the Metropolitan Water District, welded with Lincoln "Fleetweld 5" Electrode, are given joints that are just as strong and leakproof as the pipe itself, minimizing construction and maintenance costs.



TANKS can be made bigger, stronger and permanently leakproof with welded steel. Example: This two-million gallon storage tank—one of two built recently in Pittsburgh, Pa., by Hunter Steel Company with *"Shield-Arc"* Welders and "Fleetweld" Electrodes. Diameter 160 ft. Height 32 ft. Inset shows closeup of 2" fillet weld on bottom base plate.

WELDING SIMPLIFIER—The new *"Shield-Arc."* Self-Indicating "Job Selector" and Current Control provide *continuous* selection of both TYPE and INTENSITY of welding arc for easier, faster welding and better welds on every job. Diesel model shown cuts fuel costs 33% to 86%.

For further details concerning other profitable applications of "Shield-Arc" welding in construction work, consult the nearest Lincoln office or mail the coupon.

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visit to Quebec. The crown, approximately 20 ft. in height by 16 ft. in width, was built of pipe, angle iron, and sheet metal, welded together by the oxyacetylene flame. Because it is welded, the crown is smoothly joined and is practically as strong and rigid, as a single piece of metal. Its weight was only 2000 lb. because the welding eliminated nearly all bolts and overlapping surfaces. The decorative, heraldic effect of the fleurs-de-lis and military crosses along the top edge of the base was obtained by oxyacetylene flame-cutting them to shape from steel plate and welding them to the assembly. Lighting fixtures were installed so that the crown could be seen in outline at night.

MACHINE TOOL SHOW

A 1939 Machine Tool Show, to be held in Cleveland October 4th to 13th, was announced by the National Machine Tool Builders Association.

Eighty-five per cent of the exhibit space will be devoted exclusively to the showing of machine tools. The balance will contain displays of makers of machine tool accessories, and of publishers of magazines covering the machine tool field.

DRAG LINE FRAME

The base or frame of an especially large drag line, made of cast steel weighing approximately ten tons, was broken in several places.

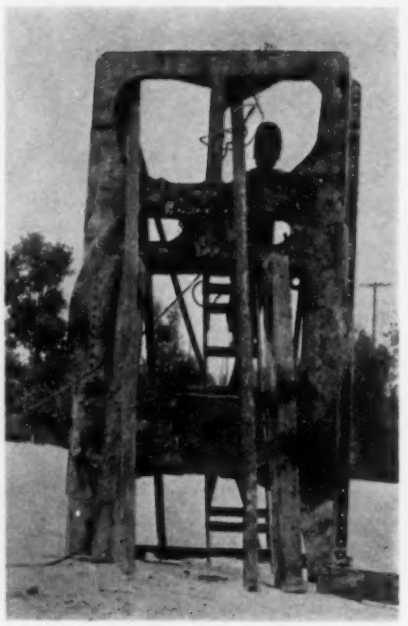


Photo courtesy Compressed Industrial Gases

After the machine was completely dismantled and the frame removed, the breaks were all veed out with a cutting torch to about a sixty degree bevel. The depth of the frame is approximately 18 inches and it varies in thickness from 3 inches to 10 inches. After each break was veed out the frame was then placed so that the welds would be in a downhand position. Two welders worked on this job continually until it was completed. Each application of electric welding was peened with an air chisel. This job was contracted by Funkhouse & Grimes of Fort Worth, Texas.

A.S.M.E. NOMINATIONS

Nominations for Officers of The American Society of Mechanical Engineers for 1940 were announced at a recent meeting of the national Nominating Committee held at State College, Pa. Election will be held by letter ballot of the entire membership, closing on September 26th, 1939.

The nominees as presented by the Regular Nominating Committee of the Society are:

President

Warren H. McBryde, Consulting Engineer, 1111 Financial Center Bldg., San Francisco, Calif.

Vice-Presidents

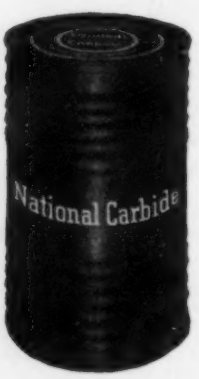
Kenneth H. Condit, Cons. Editor, "American Machinist," McGraw-Hill Publishing Co., 330 West 42nd St., New York, N. Y.

Francis Hodgkinson, Hon. Professor of Mechanical Engineering, Columbia University, 116th St. & Broadway, New York, N. Y.

J. C. Hunsaker, Head of Dept. of M.E. Mass. Inst. of Technology, Cambridge, Mass.

National

Carbide



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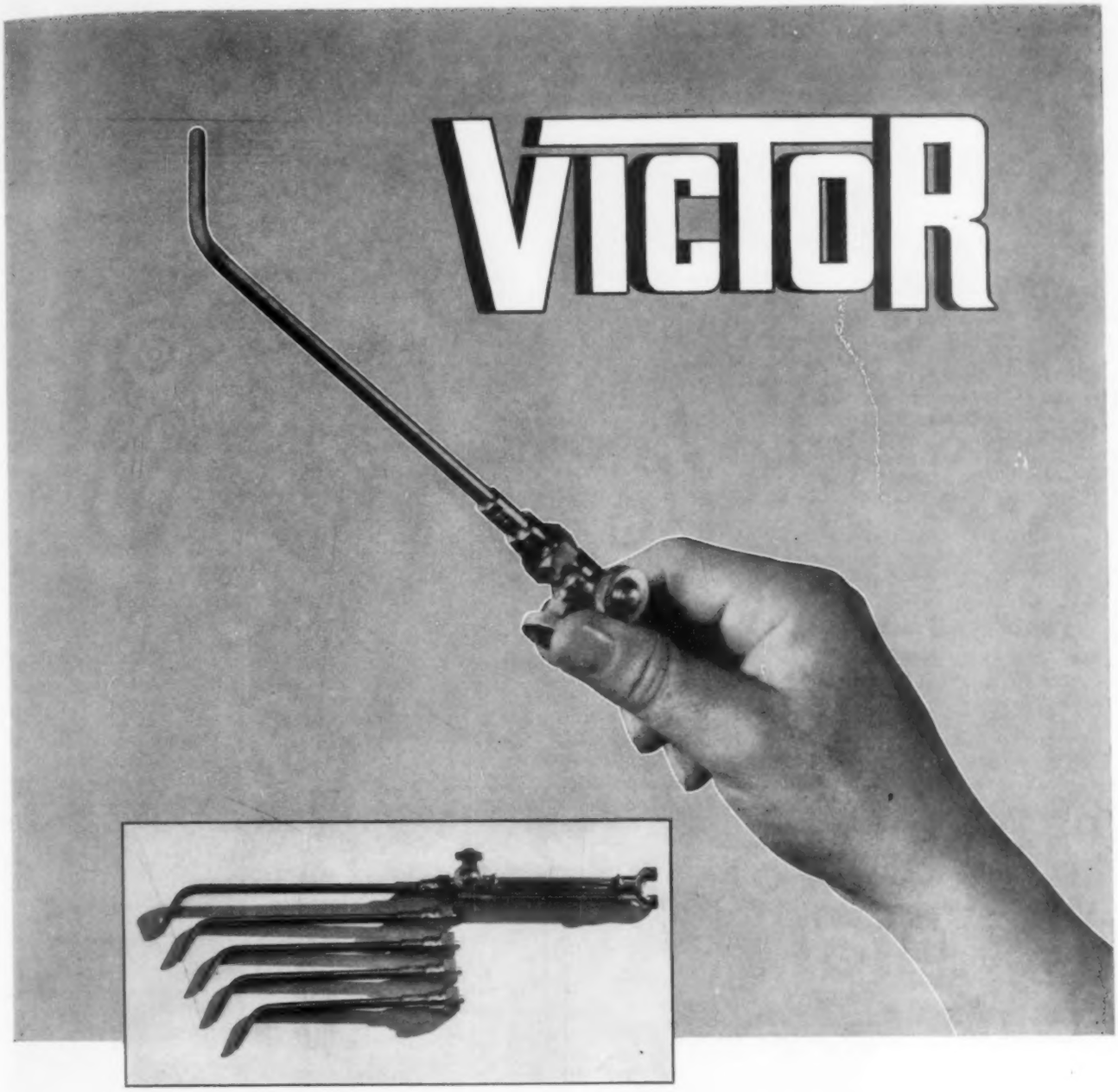

THIS TORCH MAKES LIGHT GAUGE METAL WELDING EASY

Designed for the Aeronautical, Radio, Refrigeration and Sheet Metal industries, the VICTOR Model J-20 torch offers 13 nozzles in drill sizes from No. 75 to No. 49.

Thumb-valve control makes flame adjustment easier. If you weld light gauge metals you will appreciate the advantages of this torch.

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Managers

J. W. Eshelman, President Eshelman & Potter, 1116 Martin Bldg., Birmingham, Ala.

Linn Helander, Head of M. E. Dept., Kansas State College, Manhattan, Kansas.

G. T. Shoemaker, President, The United Light & Power Service Co., 105 West Adams St., Chicago, Ill.

H. M. PRIEST ELECTED DIRECTOR

Mr. H. M. Priest has been elected as a member of the Board of Directors of the Society to fill the unexpired term of Mr. F. T. Llewellyn who resigned upon his retirement. Mr. Priest is well-known to members of the AMERICAN WELDING SOCIETY having served as Vice-Chairman of the Structural Steel Welding Committee, as Chairman of the New York Section and as author of several important papers presented before the Society.

HOYT JOINS BATTELLE

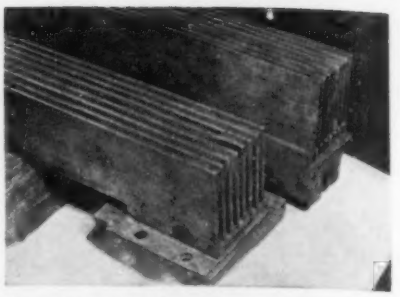
Samuel L. Hoyt, one of the best known of American metallurgists, has become a member of the staff of Battelle Memorial Institute, Columbus, Ohio. Formerly director of metallurgical research with the A. O. Smith Corporation, Dr. Hoyt will act as technical advisor in the planning and conduct of metallurgical research at Battelle, according to Clyde E. Williams, director. A considerable enlargement of the supervisory and research staff has been made necessary, Mr. Williams states, because the present rapid growth of research activity in industry has led to a marked increase in the volume of sponsored work at Battelle.

Dr. Hoyt is known particularly for his leadership in the development of cemented tungsten carbides for cutting tools and for his work on temperature-resistant alloys. At the A. O. Smith Corporation, beside the direction of a large research group, an important phase of his duties was to guide the metallurgical development of pressure vessels for the oil, chemical and related industries. This involved studies of stainless steels, nickel alloys, etc., and procedures for manufacturing the equipment to meet the specific corrosion conditions imposed in service.

BRAZING COPPER CONDUCTOR ARMS

The use of low temperature silver brazing alloys for joining heavy copper current conductors is growing rapidly. Recently the trade papers have described a number of bus bar applications as used on electroplating installations and in the power plant.

A similar application is now being used by Sperry Products, Inc., in building



The Finished Joints. Note the Sharply Defined, Clean Joints and That the Thin Film of Easy-Flo Brazing Alloy Can Hardly Be Seen

rail welding equipment. The current conductor arms, an important part of this welder, are made of copper bars 1/4 inch thick by 6 inches wide. They are brazed to a copper casting with a brazing alloy containing a medium percentage of silver, which flows freely at 1175° F. This alloy was selected for this application for four important reasons. (1) It makes joints which are ductile and high in tensile strength. (2) The electrical conductivity of the joints is as high as or higher than the copper itself. (3) Joints of solid metal cannot oxidize and never require cleaning or servicing. (4) The free flowing silver brazing alloy goes into the joint, little stays outside, little or no finishing work is needed. The conductor arms on this job are inserted in slots, 3/4 inch deep, milled in the copper castings. A low temperature flux was used which is fluid and active at 1100° F.

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MALLORY Tips and Holders

Every user of spot welding will profit from Mallory's standardization in type and sizes of tips and water-cooled holders.

Mallory's long-life, New Type tip—cold worked by a new process—guarantees quality with unheard of economies.

No matter what method you use . . . spot, seam, projection, flash . . . or what metals you are joining, Mallory has an electrode material that assures more and better welds at less cost. Write for Catalog 200-A, which shows all standard tips and holders and gives complete details of Mallory New Type tip.

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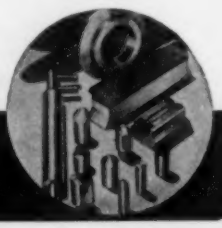

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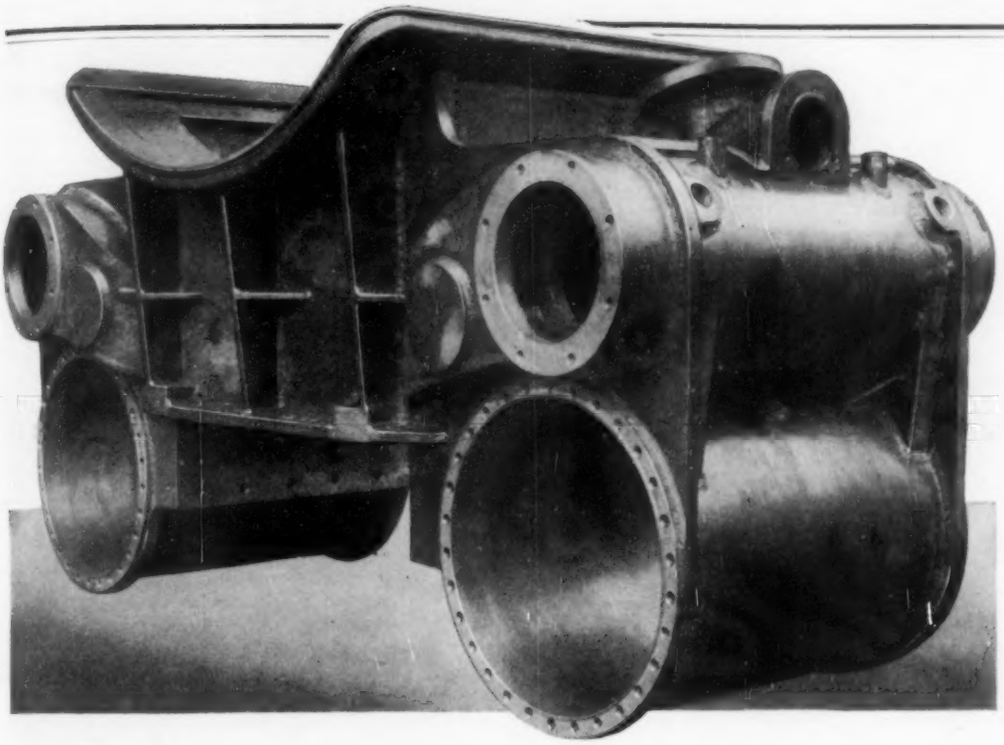
Another "IMPOSSIBLE" ROLLED STEEL JOB



"IF you can weld that, you can weld anything" was the comment of a railroad official when shown plans for fabricating a complete locomotive cylinder of rolled steel.

To make a long story short, they did build this cylinder by welding—built it from sound rolled steel. The finished weight was 25%, or more than two tons, lighter than the conventional cast construction. The cost was about 24% less than that of the corresponding cast cylinder. If, on their first attempt, a railroad welding shop can build this most complicated part from wrought steel by means of welding, what is there in railroad construction that cannot be fabricated of wrought steel.

This cylinder has been giving entirely satisfactory service on a locomotive working on heavy hauls in mountainous territory—so satisfactory that there are now under construction several more cylinder units which are to be applied to locomotives in the same service.

This triumph of rolled steel construction follows closely on the heels of equally intricate jobs. A continuous spinning machine, for example, produced at half the cost of other types of construction for a rayon plant, sets new standards of precision and produces higher quality yarn. A roller leveler, given additional strength and rigidity with rolled steel construction, saves 50% in fabrication time, 15% in weight and 5% in cost. A massive stator frame for a vertical water wheel generator is produced direct from the drawings—with a consequent reduction in cost and time.

From the simplest sort of construction to the most complicated, rolled steel has to its credit outstanding examples of time and costs saved, of improved products . . . lighter, longer-wearing and better-looking.

To designers and fabricators, foundries and welderies, we offer steels in widest range for rolled steel construction. Among them the special steels, U·S·S Cor-Ten, U·S·S Abrasion Resisting Steels, U·S·S Carilloy Alloy Steels, U·S·S Heat Resisting Steels and U·S·S Stainless Steels. Here are steels with special properties for use in strategic spots—combined with one another, with castings or plain steels as the need dictates—to combat destructive forces and give equipment longer life. And our experience in putting these steels to work where they will best perform is yours for the asking.

USS

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
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UNITED STATES STEEL

E. G. BUDD MANUFACTURING COMPANY AT THE WORLD'S FAIR

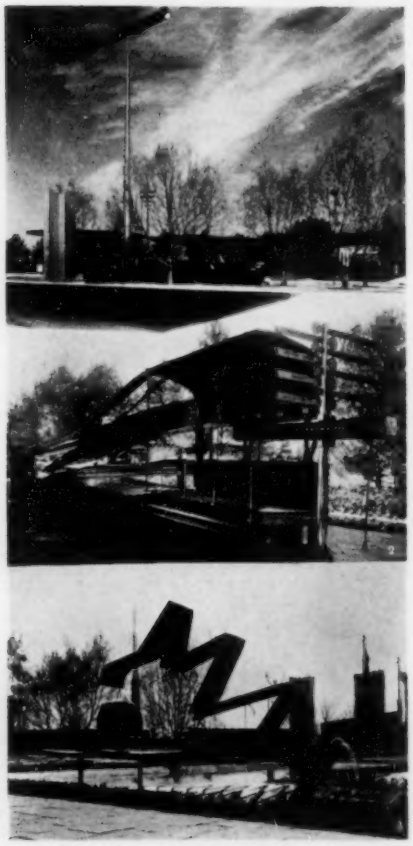


Fig. 1—Highlighting the Edward G. Budd Manufacturing Company's Exhibit at the New York World's Fair, This Huge 80-Foot Windcock, of Gleaming Stainless Steel, Towers 90 Feet Above the Ground on Its Rustless, Non-Corrosive Mast. The Exhibit Which Is Located in the Northwest Corner of the Fair Grounds and Adjourns the Railroad Exhibits, Features Budd Stainless Steel Trains, Automobile Bodies, Aircraft Parts and Countless Other Fabrications from This Unusual Alloy

Fig. 2—From Gleaming Sheets, a Solid, Rigid Car Structure Takes Form, Welded Into an Integral Mass by the "Shotweld" Method. The Cutaway Section of the Car Is Complete, Even to Center-Sill. At the Right May Be Seen a Recording Device Which Clicks Off, at the Rate of One Mile a Second, the Nation-wide Mileage of Budd-Built Streamlined Trains Now in Use

Fig. 4—These Great Disks, Sixty Feet in Diameter, Are Light in Weight Yet So Ingeniously Do They Make Use of the Structural Qualities of Stainless Steel That They Will Withstand Strong Winds Without External Bracing. Under Their Gleaming Surfaces in the Northwest Corner of the Fair Grounds, the Whole Budd Company Exhibit Has Been Arranged. The Company's Streamlined Railroad Car Exhibit Is in the Fair's Railroad Yards Nearby

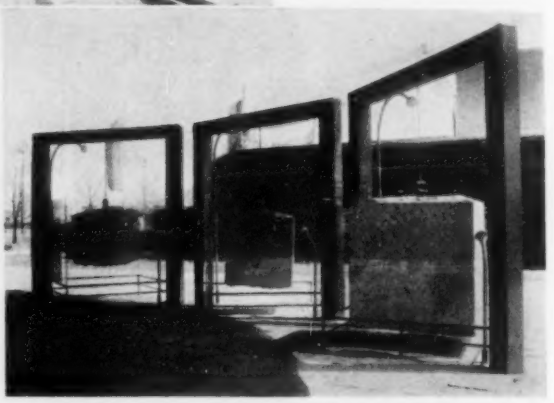


Fig. 5—A Dramatic Illustration of the Amazingly High Tensile Strength of Stainless Steel in Comparison with Other Metals. Huge Cubes of Granite Are Here Supported by Narrow Steep Strips of Different Metals, Each Strip Being Strained to Its Elastic Limit. The Cube Supported by the Stainless Steel Strip (Right) Weighs 12,880 Pounds—more than six tons! To the Left, a Strip of Structural Steel Is Strained to Its Elastic Limit by a Block Weighing 3717 Pounds—About One-Third the Weight Supported by the Stainless Steel Strip—While a Strip of Low-Alloy High-Tensile Steel (Center) Can Support a Block Weighing 5664, Which Is Less Than Half the Weight Supported by the Stainless Steel Strip. Picture Taken at the Edward G. Budd Manufacturing Company Exhibit at the New York World's Fair

Fig. 3—Wrought Into a Spectacular Structural Design Which Seemingly Defies the Force of Gravity, This Structural Steel Fountain Is the Centerpiece of the Exhibit. The High Tensile Strength and Adaptability of Stainless Steel in Fabrication Make the Structure Possible

THESE TRAINS MAKE MONEY

The first of the American lightweight, streamlined trains went into service in 1934. About eighty of them now are operating on some twenty railroads. They were, and still are, a new development in the long and romantic story of American transportation. However, the most striking thing about them, perhaps, is the fact that every lightweight, streamlined, high-speed train operating in the United States has meant additional passenger traffic and substantial earnings for the railroad placing it in service.

Certainly not so much can be said for the older type of American passenger trains. The passenger business in these United States has been sick for a long time.

The stainless steel, lightweight Zephyrs, moving between Chicago and Denver, showed the highest ratio of earnings for any train of the new type, for the year ending June 30, 1938. With a gross revenue of $2,088,938 these trains earned a net of $1,568,831. This was 75.1 per cent of the gross or $2.07 per train mile.

The high-speed streamlined Hiawathas, between Chicago and the Twin Cities had a gross revenue of $1,337,898, with net earnings of $3.22 per train mile or 74.1 per cent of the gross.

Usually the new trains show a steady increase in revenues for a considerable period after going into service. The El Capitans, between Chicago and Los Angeles went into action in February 1938. They produced $8000 in revenues that month; $38,000 in March; $49,000 in April; $83,000 in May and $101,000 in June.

Undoubtedly the day of the old time coach service is just about over. While the new trains are not the answer to the railroad passenger problem everywhere their showing in earnings and popularity seems to be an excellent answer to the question "What can the railroads do to help themselves?"

It is significant that welding plays its part in the construction of these trains.

FROST TRANSFERRED

Mr. L. H. Frost, Educational Chairman of the Cleveland Section, has been made District Manager at Detroit for the Thomson-Gibb Electric Welding Company.

NATIONAL METAL CONGRESS AND EXPOSITION

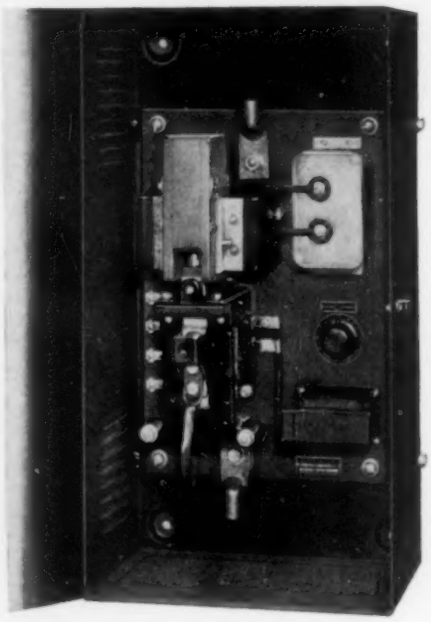
William H. Eisenman, Managing Director of the National Metal Congress and Exposition and secretary of the American Society for Metals, has announced that acceptances for joint sponsorship of the congress have been again approved by the Wire Association, the AMERICAN WELDING SOCIETY, The Institute of Metals Division and the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers, and the American Society for Metals.

Portions of the program yet to be announced will be devoted to discussions by leaders in the various societies listed. Announcement of the completed program will be available about August 15th.

In addition to the previous announcement, regarding capacity of contracts signed for show space, other contract holders bring the total very near to capacity.

According to Mr. Eisenman, all indications point to one of the largest attendance figures on record during the 21 years of the National Metal Congress and Exposition.

No ARCING or BURNING of CONTACTS with this new *Syncro-Break* CONTACTOR



● If an AC circuit is broken at the zero point on the load current wave, there can be no arcing. Because the Square D ***Syncro-Break*** contactor always breaks at that point, burning of contacts is eliminated and higher ratings are made possible. The first cost of the equipment is low and maintenance is reduced to a minimum.

The syncro-break principle, when applied to a special contactor and used with a synchronous motor driven precision timer, provides accurate timing periods as short as one-half cycle.

Inexpensive, easily installed and operated, the precision control permits welds heretofore practical only with costly and intricate equipment.

Write to the Square D Company, Milwaukee, Wisconsin, for an interesting bulletin on "Resistance Welding."

CALL IN A SQUARE D MAN

SQUARE D COMPANY

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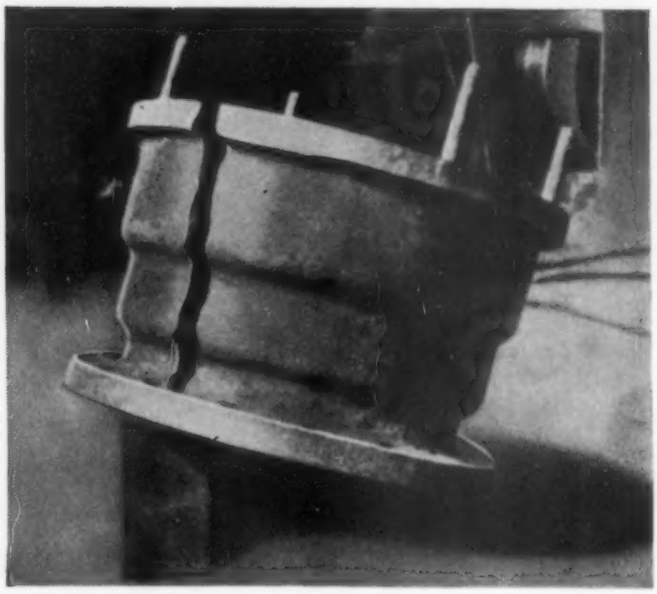
What would you do in an emergency like this?



A GREAT LAKES FREIGHTER was carrying a valuable cargo of perishable goods when its engine suddenly became disabled off Fort William, Ontario.

Hurried examination revealed the badly cracked iron casting shown above. Because of the cargo, minutes meant dollars, and repair-welding was obviously the only way out.

Before looking to see how this problem was solved, why not figure out what you yourself would have done.

39133

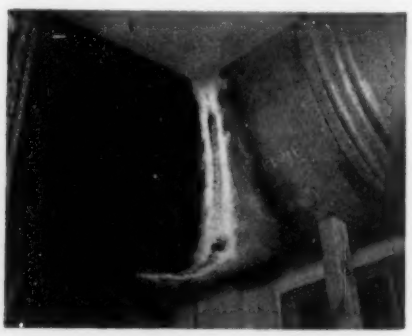
Check your answer with the solution on page 502

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

BRONZE ROD

An interesting welding application was recently completed in which the new product, CIG No. 401 Ready Fluxed Manganese Bronze Rod, a product of Compressed Industrial Gases, Inc., Chicago, Illinois was used.



The new Ready Fluxed Bronze Rod pleased both the welders and the engineers at the City Water Department in Racine, Wisconsin. The work was done by Robert Gordon, Inc., of Chicago and the men in charge pronounced the job completely satisfactory in every respect.

As the pictures indicates, the job was that of welding a 42-inch steel pipe into a 42-inch cast-iron water main. The wall of the cast-iron pipe was $1^1/_2$ inch thick and the steel pipe was $^3/_8$ inch thick.

The weld was completed by two welders in six hours, and when tested it was found to be thoroughly sound. The cast-iron pipe was very dirty, having been in service for some time, but after the scale was removed it was found that the new bronze worked very satisfactorily.

There was a charcoal fire built on the inside of the cast-iron pipe to preheat to approximately 400°. The bronze weld was started from the bottom. One man worked from each side, and the weld was completed at the top without any cracks developing.

HEAVY-DUTY WELDING AND HEATING BLOWPIPE

Literally hundreds of such metalworking operations as forging, forming, straightening, bending and pressing can be effectively and economically performed with the aid of the intense, localized heat of the oxyacetylene flame. Of late, the usefulness of the oxyacetylene flame for these "smithing" operations has been greatly increased by the availability of the large-capacity heating blowpipe. This blowpipe, distributed by The Linde Air Products Company and known as the Oxweld (Type W-26) Heavy-Duty Welding Blowpipe, is for welding and heating ranges above those which can be handled by the ordinary blowpipes. It delivers a tremendous amount of heat to a localized area, and does this so quickly that metalworking and heat treating can be accomplished at top speed.

Extensions for the welding head are available for extra-heavy work, doing away with the necessity for heat shields. The operator works in comfort, away from the source of heat, and finds the blowpipe, even with the extension, easy to handle because of its excellent balance.

STAINLESS ELECTRODES

A complete line of stainless steel electrodes covering all chemical analyses—claimed by the manufacturer to be an advancement in uniform, high-quality weld deposits—is offered by The McKay Company, Pittsburgh, Pa.

These electrodes are known as McKay Certified Stainless Electrodes and the makers state that each package contains a certification of weld deposit analysis rather than the wire analysis which has been the practice of manufacturers in the past.

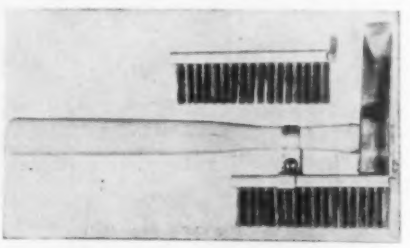
Further claims for superiority are as follows:

1. Instant contact upon restriking arc.
2. Maximum ease of slag removal.
3. Spatter free within practical limits.
4. Exceptionally smooth bead with perfect weld contour.
5. All alloys contained in core wire.

A sixteen-page booklet describing the certification process of weld deposit analysis and the welding procedure for the various stainless steels may be obtained by writing the Sales Office of The McKay Company at York, Pa.

COMBINATION CHIPPING HAMMER AND WIRE BRUSH FOR WELDERS

A new convenience tool for welding departments is the Triplex Welders' Chipper, manufactured by St. Pierre Chain Corporation, Worcester, Mass. It consists of a drop forged steel chipping hammer with hardwood handle, having a heavy duty wire brush rigidly mounted on the top side. The hammer chisel chips and



breaks the scale, then the tool is turned in the hand and the brush is used to clean the surface.

HARD SURFACING POWDER

"Surfaceweld A" is a fine grain alloyed powder to be applied with the carbon arc produced by The Lincoln Electric Company, Cleveland, Ohio and giving a smooth dense hard (abrasion resistant) surface. It can be applied in a very thin layer if desired.

REGO

WELDING AND CUTTING EQUIPMENT

- Welding Torches
- Cutting Torches
- Economizers
- Regulators
- Outfits

FOR PLUS PROFIT SPECIFY REGO

Send for Catalog R-120 — with it you will have all the specifications you need for the buying of highest quality welding and cutting equipment.

The BASTIAN-BLESSING Company

282 E. ONTARIO CHICAGO

NET ADVERTISING RATES

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Space	One Insertion	Three Insertions	Six Insertions	Twelve Insertions
*Full Page	$100	$90	$80	$70
Half Page	60	50	45	40
Quarter Page	35	30	27	25
Eighth Page	25	20	17	15
*Inside Preferred	115	105	95	85

*10% Extra for bleed full pages. Color $40 extra per color added.

ROEBLING

the custom-made wire for exacting welders

★ BARE WELDING ELECTRODES

★ COVERED WELDING ELECTRODES

★ GAS WELDING WIRE

ROEBLING WELDING CABLES:

Made in a complete line of rubber and braided types for arc welding purposes.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N.J.
Branches in Principal Cities

ONLY A FINE PRODUCT MAY BEAR THE NAME ROEBLING

This material when properly applied will give a coating with a hardness of approximately Rockwell 54C. This hardness will vary somewhat depending upon the amount of admixture with the base metal to which it is applied. It should be noted however, that hardness has little relation to abrasion resistance.

This alloy develops its full hardness in the as-deposited condition, maintains its hardness at high temperatures and resists scaling at high temperatures. The deposit cannot be softened by annealing.

Under many conditions it is quite corrosion resistant, but this is not universally so. Corrosion resistance will compare favorably with that of Stainless Steel.

Its resistance to abrasion is excellent. One of its big advantages is that it can be applied in very thin and extremely smooth layers. The limit of the thinness of a layer is governed from a practical standpoint when the deposit becomes so diluted with the base metal that the "Surfaceweld A" will not flow properly. A deposit as thin as 0.025 can be applied to light metal, such as 12 to 20 gage.

LOW-COST WELDER

The Harnischfeger Corporation of Milwaukee, announce the new P & H-Han-

sen Model WA-200 square frame welder for multi-arc service. The WA-200 requires less than $3\frac{1}{2}$ sq. ft. of floor space, offers a welding range from 40 to 225 amp.

ELECTRIC AND GAS GENERATORS COMBINED

The Young Sales Company, Inc., of Milwaukee has recently introduced a double-duty gas and electric welding unit which combines the P & H-Hansen 150 ampere portable welder manufactured by the Harnischfeger Corporation of Mil-

waukee, and gas equipment manufactured and developed by Young Sales Company, Inc.

This unit, representing the very latest development in the combination gas and electric portable welder is shown in the photograph above. The electric welding unit consists of a P & H-Hansen 150 ampere generator coupled to a Wisconsin Air-Cooled motor mounted on the standard P & H Trailer. Used in connection with this unit, as shown, is complete gas welding and cutting equipment. This is made up of nationally known makes of welding and cutting torches, regulators and associated equipment.

FACE-SHIELD BULLETIN

A bulletin covering a new line of face-shields, which are now being widely used to protect workers from dust, sparks, heat and glare, has been published by the Davis Emergency Equipment Company, 55 Van Dam Street, New York City.

The line described in the bulletin consists of four different types of face shield, ranging from a light weight, visorless shield to a shield with a fiber visor that protects the front part of the head from lacerations and bumps. All types are provided with replaceable transparent Plastacele windows which resist heat, acids and caustics and are furnished in clear, green or amber colors.

PREVENTING ADHESION OF WELD SPATTER

Glyptal 1294 Gray, a recent addition to General Electric's line of welding accessories, was developed to meet the need of fabricators for a material which, when applied to metal to be lap welded, would prevent corrosion at the point where the plates overlap. It is a pigmented version of the previously announced Glyptal 1294 Clear and will, like the latter, prevent the adhesion of weld spatter when applied to parts before welding. On lap welds it will prevent corrosion at the overlap. At the same time it serves as an excellent base for painting.

Glyptal Gray can be sprayed or brushed and the work can be left exposed to the atmosphere until fabrication is complete with the assurance that edges of the parts will not need cleaning before the final welding operation. For this reason, it is expected that it will prove popular with shipbuilders, pipe and tank manufacturers, and other fabricators of products which make use of lap-welded joints. Such fabricators can order their steel coated with Glyptal Gray at the mill and can store it in exposed places until needed.

TRANSFORMER

The Owen Electric Manufacturing Company of Fayetteville, N. C. announces the development of a new oscillating current transformer type electric welding machine.

Features claimed for these machines are: High Efficiency, High Power Factor and Ease of Operation.

Open circuit voltages of 65 and 90 are fixed. The stepless range of machine at

65 volts is 20 to 445 amperes. Any desired setting is obtained by turning hand wheel attached to movable reactor core.

The high efficiency, high power factor and high welding qualities are the results of a system utilizing inductively, highest quality (non-inflammable) oil-filled condensers, in both primary and secondary circuits, which are automatically thrown in and out.

NEW AC ARC WELDER

Hobart Brothers are announcing a new and attractive AC Arc Welder with many new outstanding features for ease of handling and high efficiency of operation. The new welder has a range of 20 to 200 amperes and is to be used on 220 single-phase power lines.

The makers claim the new improved features incorporated in the "Transarc" AC Arc Welder greatly broaden the application of welding in many fields, such as garages, repair shops, sheet metal shops, bus and truck fleet repair shops, plumbing and piping works, welding shops, blacksmiths, machine shops, manufacturers,

maintenance and general repair as well as a wide variety of metal fabricating shops.

PAGE

Hi-Tensile "G"

for welds that must stand **heavy strain**

● *Jobs like welding the circle frame of a road grader, as shown above, are "duck soup" for Page Hi-Tensile "G". For Hi-Tensile "G" produces joints that withstand shock and strain. Produces them at a profit, too.*

Any welder who has run Page Hi-Tensile "G" can tell you it's a remarkably fast rod, quiet-running and with very little spatter. It produces a smooth bead and is good for production, maintenance and construction work.... Your local Page distributor will give you full information.

BUY ACCO QUALITY *in Page Welding Electrodes, Page Wire Fence, Lay-Set Preformed Wire Rope, Reading-Pratt & Cady Valves, Campbell Cutting Machines, American Chains and Ford Chain Blocks.*

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109 LINCOLN FOUNDATION AWARD STUDIES NOW AVAILABLE IN BOOK FORM

109 original studies of welding by acknowledged leaders in various branches of industry are contained in the new book, "Arc Welding in Design, Manufacture and Construction," just published by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. These studies are the outstanding papers of the recent $200,000 Award Program.

Feeling that the award papers constitute a large and valuable source of scientific study, research and information on welding, the Trustees decided to make the material generally available. The book has been under preparation for six months.

With few exceptions, the papers are reproduced in complete form. Only those which were too lengthy for inclusion in their entirety are in the form of comprehensive briefs. All photographs and drawings essential to a clear and adequate presentation of each subject are included. Each study includes designs, calculations, procedures and other pertinent information showing how the advantages attributed to arc-welded construction are obtained.

The contents of the book are arranged as chapters of 10 sections. The sections and chapters are as follows:

Section I, Automotive

9 Chapters, 89 pages, 47 illustrations

Subjects of Chapters—(1) School bus body; (2) line truck body; (3) side-dump trailer; (4) refuse collection body; (5) bus bodies; (6) trailerized tank; (7) roller frame assembly; (8) tractor construction; (9) house trailer.

Section II, Aircraft

6 Chapters, 74 pages, 38 illustrations

Subjects of Chapters—(1) Aircraft heating; (2) co-ordinated construction; (3) beaching gears; (4) landing gear fork; (5) outer wing panel; (6) welding in airplane design.

Section III, Railroad

11 Chapters, 130 pages, 60 illustrations

Subjects of Chapters—(1) Locomotive frame; (2) locomotive body; (3) locomotive boiler; (4) freight cars; (5) steel car roof; (6) motor rail car; (7) open-framed coaches; (8) light weight passenger coach frame; (9) tender tank; (10) locomotive and car parts; (11) tender frame.

Section IV, Watercraft

9 Chapters, 115 pages, 71 illustrations

Subjects of Chapters—(1) Modern methods and modern steels in shipbuilding; (2) deck barge; (3) lake bulk freighter; (4) railroad car float; (5) towboats; (6) wharfboat; (7) pleasure cruisers; (8) auxiliary cutter yacht; (9) small pleasure craft.

Section V, Structural

14 Chapters, 248 pages, 113 illustrations

Chapter Subjects—(1) Welded diagonal grid; (2) mill building; (3) industrial building; (4) radical departure in large roofs; (5) theater construction; (6) single-frame dwellings; (7) welded steel residence frame; (8) plate floors for bridges; (9) two-span rigid frame for highway grade separation; (10) five-span highway bridge; (11) bridge for secondary roads; (12) railway trestle; (13) elliptical tainter gate; (14) steel facing for dams.

Section VI, Furniture and Fixtures

7 Chapters, 36 pages, 17 illustrations

Chapter Subjects—(1) Lecture room chair; (2) all-purpose steel table; (3) chromium tubular furniture; (4) desk and seat frames; (5) sheet steel bath tub; (6) lighting fixture; (7) wrought iron candlesticks.

Section VII, Commercial Welding . . . Automotive Repair . . . Welderies

4 Chapters, 106 pages, 47 illustrations

Chapter Subjects—(1) Operating a job welding shop; (2) how to increase business in the garage; (3) commercial weldery; (4) organizing, equipping and operating a plant weldery.

Section VIII, Containers

11 Chapters, 156 pages, 64 illustrations

Chapter Subjects—(1) Oil well casing; (2) thimble tube and watertube boilers; (3) 800,000-gallon storage tank; (4) economic type boiler; (5) stationary steel tank; (6) hydraulic turbine scroll cases; (7) steel mill pipe line; (8) penstock of nickel-clad steel; (9) pipe lines for paper board cylinder machine; (10) eliminating flange joints on piping; (11) modernizing a large brewery with welded piping.

Section IX, Machinery

29 Chapters, 382 pages, 190 illustrations

Chapter Subjects—(1) Rotary planing machine; (2) flat bed planer; (3) contour machining; (4) riveting machine; (5) high-speed metal forming press; (6) spiral casing for water turbine; (7) prewelding turbine blades; (8) prime movers; (9) elevator machine; (10) hoisting and conveying equipment; (11) motor truck winch; (12) propeller type pump; (13) deep-well turbine pump; (14) business machinery; (15) hydraulic manifold; (16) pressing machine; (17) asphalt paving plant; (18) oil pump motor base; (19) machine for manufacture of composite metals; (20) steel mill table roller; (21) rotary plow; (22) coal stoker; (23) bread slicer; (24) continuous rayon producing machines; (25) textile cutting machine; (26) platen press frames; (27) manipulator; (28) 200-inch telescope; (29) machine for oxidizing roast of gold-bearing ore.

Section X, Jigs and Fixtures

9 Chapters, 65 pages, 48 illustrations

Chapter Subjects—(1) Welding fixture; (2) large two-position drill jig; (3) milling fixture; (4) fixture for bedplates; (5) hardening fixture; (6) tilting fixtures; (7) revolving adjustable tilting table chuck; (8) dies; (9) typical welded jigs and fixtures.

"Arc Welding in Design, Manufacture and Construction," contains 1408 pages and a total of 695 numbered illustrations, including photographs and line drawings. The book has a 32-page section at the front giving information regarding the Foundation and the $200,000 Award Program, the Jury of Award's certification of papers for award, an alphabetical listing of authors, in addition to the preface and table of contents. Each section of the book begins on a right-hand page. Facing on the left-hand page, are photographs of authors in that particular section.

The book is a convenient desk size, 6 inch x 9 inch with dark reddish brown simulated leather cover, gold embossed.

The book is priced at $1.50 per copy, postpaid anywhere in the United States $2.00 elsewhere.

BLUEPRINT READING

A new book entitled "Simple Blueprint Reading with Particular Reference to Welding and Welding Symbols" is announced by The Lincoln Electric Company, Cleveland, Ohio.

While "Simple Blueprint Reading" has been compiled and published primarily for welders, it contains information of value to any one concerned with mechanical construction. Its object is to provide information and instruction on the reading of blueprints and drawings. The book affords a basis for study which, together with practice in the actual reading of drawings, will guide the student to proficiency in this important subject.

WELDING LABORATORY

Possibly the most flexible, most complete source of welding power is this Westinghouse welding laboratory installed for The Linde Air Products Company at Niagara Falls. Used in connection with

their Unionmelt welding process, the installation provides 4000 amperes alternating current and 2000 amperes direct current. The four 1000-ampere air-cooled transformers can be seen, with their current-setting indicators, above the control panels. Direct current is provided by

The resistance welder manufacturers association design requirements protect the user against inexperience in some particular phase of welding engineering insofar as unified thought and rigid standards are established which cover standard machine practices and greatly benefit special machine construction by providing definite requirements as to transformers, current carrying members, welding pressures, quality of alloys, auxiliary accessories, etc.

These published standards are the result of accumulated experience in many problematical applications of resistance welding.

Resistance Welder Manufacturers Association

505 Arch Street — Philadelphia, Pa.

MEMBER COMPANIES

Acme Electric Welder Company, Los Angeles
American Electric Fusion Corporation, Chicago
Eisler Engineering Company, Newark, N. J.
Expert Die & Tool Company, Detroit
Federal Machine and Welder Company, Warren
Multi-Hydromatic Welding and Manufacturing Co., Detroit, Mich.
National Electric Welding Machines Co., Bay City
Progressive Welder Company, Detroit
Swift Electric Welder Company, Detroit
Taylor-Hall Welding Corporation, Worcester
Taylor-Winfield Corporation, Warren
Thomson-Gibb Electric Welding Co., Lynn
Welding Machines Mfg. Company, Detroit

ASSOCIATE MEMBER COMPANIES

P. R. Mallory and Co., Indianapolis
S-M-S Corporation, Detroit
Electroloy, Inc., New York
Welding Sales and Engineering Co., Detroit

rotating machines not shown in this view. On the panels are indicating and recording meters, and switches and links by which almost any welding voltage of either type can be switched to any feeder in the building.

MEDIUM HIGH CARBON ELECTRODE

General Description.—"Hardweld 50" is a medium carbon steel electrode produced by the Lincoln Electric Co., Cleveland Ohio, designed for the building up of steel parts and surfaces. The deposit has considerable resistance to deformation and wear and is machineable at slow speed.

The dipped coating stabilizes the arc and permits the deposition of a tough dense medium carbon steel.

In general, when deposited on straight carbon steel and allowed to cool naturally, the hardness of the deposit will be approximately 20–35 Rockwell C. The exact hardness will depend somewhat on the rate of cooling and the analysis of the steel on which it is deposited. Deposit may be hardened by the usual water quench from above approximately 1500° F.—or by flame hardening methods.

Uses.—Surfaces which require more resistance to deformation, and wear than low-carbon steel but must still be machineable: Shafts, axles, collars, flanges, locomotive and tractor parts, agricultural implements, vise jaws, etc.

Also used extensively for building worn parts up to size before applying the harder facing alloys.

THE PRICE OF SILVER IS LOWER!

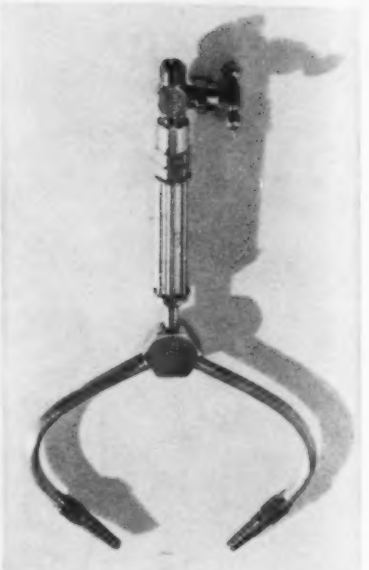
Out of the confusion of Washington politics silver has recently emerged with its price basis changed.

Such a change of, roughly, 15% naturally affects the arts and industries where silver is used in large volume. The industrial uses of silver, which have expanded rapidly in recent years, especially in the making of brazing alloys for joining ferrous and non-ferrous metals, should benefit particularly from the lower commercial prices.

LOW-TEMPERATURE BRAZING TORCH

Victor Equipment Company, San Francisco, California, is now producing, among other welding and cutting equipments, specially designed torches to meet the increasing demands for various types of low temperature brazing operations.

The torch here illustrated operates on the Bunsen Burner principle and may be provided with tips to utilize acetylene or other usable fuel gases.



This multi-head brazing torch illustrates but one of several designs adaptable for specific operations where two or more flames, suitably arranged, facilitate low temperature brazing of circular or irregularly shaped objects.

» » » SECTION ACTIVITIES « « «

CHATTANOOGA

The Chattanooga Section held their regular meeting on June 16th in Hotel Patten. The principal speaker was Mr. A. J. Moses, General Manager of the Hedges-Walsh-Weidner Division of the Combustion Engineering Co. The subject of his talk was "Welding of Pressure Vessels." He also presented a moving picture of the hot bending of heavy plate into cylindrical shapes for boiler drums.

This meeting closed the 1938–39 season.

CLEVELAND

Members of the welding fraternity were invited to attend the Membership Committee dinner rally held at Brown's Cottage June 16th. Membership plans for the coming year were presented and everybody was urged to bring in one member per man per month. The plan was enthusiastically received.

COLORADO

At the June 14th meeting of the Colorado Section the annual election of officers was held, at which time the following were elected.

Chairman—J. H. Johnson, Johnson Supply Co.

Vice-Chairman—G. H. Garrett, Thompson Manufacturing Co.

Secretary-Treasurer—H. W. Creager, Hendrie & Bolthoff Mfg. and Supply Co.

Executive Committee—H. J. Jackson and Clive McClure.

DETROIT

The final meeting of the 1938–39 season of the Detroit Section was held on June 2nd at the Detroit Leland Hotel. The subject of the meeting was "Brazing with Low Temperature Alloys" and the speaker was Mr. Leo Edelson of the Handy and Harman Company. There were approximately 125 present. The talk was followed by a practical demonstration of silver brazing which was very interesting to all present. Refreshments were served at the close of the meeting, which was one of the most interesting meetings of the year.

INDIANAPOLIS

The Indianapolis Section of the AMERICAN WELDING SOCIETY held one of the most instructive and progressive meetings that have been held this year.

With Mr. John Tebben, presiding, the meeting was opened with an informal lecture by Mr. K. L. Hansen, the District Vice-President who came to Indianapolis from Milwaukee for a double purpose, i.e. to give some ideas that have been incorporated in the Milwaukee Chapter and to present some new results of some research work that he has personally been doing.

The Indianapolis Section is going to have some extra speakers at the meetings who will give a short dinner talk and discussion while the dinner is going on, followed by the regular technical meeting and Mr. Hansen's ideas about the methods of promoting greater interest in the technical side of welding will be helpful.

This meeting closed the formal session and the next meeting will be the regular picnic at Forrest Park and an attendance of 132 is expected who will spend the day with games and sports and the evening enjoying a dinner and informal discussion.

LOUISIANA

The newly organized Louisiana Section has set the first Friday of each month as their regular meeting date and the Isaac Delgado Central Trades School, New Orleans, as the meeting place.

The Louisiana Section held its first regular meeting on July 7th. The program included a moving picture of the "Unionmelt" process sponsored by The Linde Air Products Company, which was very interesting.

Luncheon in the cafeteria of the school followed the program. The Isaac Delgado Central Trades School has offered all of its facilities, gratis, to the Louisiana Section for their meetings. There were twenty members and forty-eight guests present.

The following committees were changed as follows:

Program—H. H. Helper, Chairman, E. B. Farree, Wm. Wishart and A. L. Clothier.

Membership—Harry J. Earl, Chairman, Eugene Barrios, G. O. Huet and Mace H. Bell.

Executive Committee for 2 years—A. H. Guillot, M. H. Bell, H. H. Helper and H. J. Earl.

Executive Committee for 1 year—W. Wishart, E. C. Higgins, Victor Leaveau and E. B. Farree.

MARYLAND

The Maryland Section will not hold another meeting until their famous Oyster Roast in October. The Section reports that the American Electric Welding Company is doing a fine job of building all steel boats, all welded, from 30 to 60 feet at a much lower cost than wood structure.

NEW YORK

The New York Section Executive Committee held a meeting on July 11th and laid plans for the coming year. It has been tentatively decided to arrange the fourth lecture course for the New York Section to deal with the A, B, C of the fundamentals of metallurgy and metallography, with particular reference to welding. A charge of $2.00 will be made to members and $5.00 to non-members attending the course. The price will include the ten lectures in attractive pamphlet form.

The tentative program for the regular meetings of the Section for the coming year includes lectures on Welding High Pressure Pipe, Welding of Pressure Vessels, Structural Steel Welding, Preparation for Welding by Gas Machine Cutting, Aircraft Welding, Flame Hardening and Softening, Ship Welding and Weldability of Steels. Many of these meetings will be arranged as joint meetings with other societies.

NORTHERN NEW YORK

The Northern New York Section of the AMERICAN WELDING SOCIETY held its annual meeting for the installation of Officers at the New Kenmore Hotel, Albany, N. Y. on Thursday, May 25th. The following are the officers for the ensuing year:

Chairman—R. W. Clark
1st Vice-Chairman—W. C. Hutchins
2nd Vice-Chairman—E. F. Potter
Secretary-Treasurer—G. A. Ross

Members of Executive Committee:

Term expires May 1940 E. J. Myers
Term expires May 1941 E. R. Spittler
Term expires May 1942 F. H. Miller
Term expires May 1942 G. G. Somerville

OKLAHOMA CITY

The second annual meeting of the Oklahoma City Section was held on June 14th at Belle Isle Park. The meeting was entirely informal, and the program consisted of the reports of the chairmen of the various committees who have served during the past year.

The report of the Program Committee was presented by Chairman C. C. Willis. His report indicated the splendid work which he did toward providing the speakers for the various meetings, and his efforts were rewarded by the high caliber of the speakers which he was able to obtain. His work did much toward the success of the Section during the past year.

Mr. M. F. Dunne presented his report as Chairman of the Membership Committee, and while the committee was very active throughout the year, it seems as though memberships were difficult to secure and equally hard to hold. Some of these losses, however, are attributable to transfers into other Sections, or as was the case of a number of student members, discontinuing their courses or graduating.

The report of the Educational Committee was given by Chairman Charles Bowen, who reviewed the work done by that committee in presenting a program of educational lectures and motion pictures on the subject of "Arc Welding, Acetylene Welding and Welding and Cutting in Machinery Construction." These lectures were well attended and proved to be of considerable benefit to the members.

One of the most interesting reports made was that of the Treasurer, Mr. Otto Hart. His report indicated that the retiring officers had conducted the Section in a sound and economical manner, with the result that the incoming officers found the Section in a very healthy state financially.

An equally interesting report was made by Joseph M. Mideke as Chairman of the Tellers Committee. His announcement of the results of the election of officers for the incoming year, was to the effect that the following were elected:

Tinned top and bottom for convenient hanging in office or shop.

BETTER WELDING RESULTS..

are obtained by the selection of the proper welding rod for each job. Our up to date modern selector chart will prove of valuable assistance in making these selections. This chart is lithographed in three colors, size 24" x 36" and lists 33 different rods. The name color identification, uses, procedure, current values and physical properties are listed for each individual rod. Don't be without one—Save time and trouble—Write today.

HOLLUP CORPORATION
3357 W. 47th Place Chicago, Ill.

FREE SEND FOR CHART TODAY

HOLLUP CORPORATION
3357 W. 47th Place, Chicago, Illinois
Please send without obligation a copy of your selector chart.
Company
Address
City State
Name Position

Chairman—K. B. Banks
Vice-Chiarman—Francis Sprehe
Secretary—C. C. Willis
Treasurer—W. B. Klein

Executive Committee—J. M. Mideke, Clovis Gee, Geo. E. Day, C. C. Willis, Chas. Bowen, L. E. Acker, O. T. Barnett and D. F. McCandlish.

Program Committee—O. T. Barnett, J. M. Mideke and Howard Simms.

Membership Committee — Francis Sprehe, J. M. Grissman and W. D. Brewer.

Educational Committee—Wm. Tiffin, O. T. Barnett, J. Lang, Justin Roach and W. H. Rice.

Following the announcement of the newly elected officers, Mr. O. T. Barnett, retiring Chairman, gave a brief résumé of other activities in which the Section had taken part, such as the Welding Conference held at the University of Oklahoma at Norman, meetings in connection with municipal and state authorities relative to the application and adoption of welding codes as applied to power piping; meetings with municipal and state authorities in connection with regulatory measures for the use of liquefied petroleum gases and also meetings with the municipal fire warden in connection with proposed ordinance regulating use of acetylene generators and arc welding machines.

Mr. K. B. Banks, as the incoming Chairman, stressed the need for more constant effort toward maintaining the membership and toward securing new members. He also solicited comments from the membership as to suggestions and ideas for making the meetings more interesting and beneficial.

PEORIA

The Program Committee of the Peoria Section is planning on an eight-lecture Educational Series to start September 20th and continue with a meeting every second week until December 20th. The program is planned to consist of lectures by guest speakers and moving pictures which will cover, in a general way, all of the major classes and methods of welding, and will illustrate each class or method by specific descriptions and pictures of applications in that class. The Program Committee, headed by Walter J. Brooking, is well started on its schedule, and expects to have the program complete in the near future. The regular monthly meetings will be held during the spring months of 1940.

PUGET SOUND

The first regular meeting of the Puget Sound Section was held on June 5th at the Engineers' Club, Seattle, Wash. The business meeting was followed by a technical discussion of "Non-Destructive Testing of Welds," by W. W. Ofner, of the Industrial X-Ray Laboratory.

The Section is planning during the latter part of September to make a field trip to Coulee Dam to inspect the welding operations being conducted there by the Western Pipe and Steel on the large penstock sections being constructed for this project.

Two additional field trips for the summer activities, are being planned, one to the Boeing Airplane Company in Seattle and one to the Puget Sound Navy Yard at Bremerton, Washington.

TULSA

The Tulsa Section announces the election of the following officers:

Chairman—G. L. Wiley
Vice-Chairman—Forrest-Hoffman
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At the last Board of Directors meeting of the Section, it was decided to continue holding meetings throughout the summer.

At the June 20th meeting Mr. L. R. Hodell and Dr. W. A. Bruce, research engineers for the Carter Oil Company, spoke on the following subjects: Mr. Hodell—"Application Critical Data in Field Welding of Casings." Dr. Bruce—"Temperature Determination in the Cooling Beads of Arc Welding in Steel Casings."

LIGHTING EQUIPMENT

Welding plays an important part in the fabrication of lighting equipment. This operator in the shops of the Westinghouse Lighting Division is welding the bottom of

a tank for an isolating current transformer for series street-lighting circuits. On this semi-automatic machine the drawn-steel tank is held between motor-driven rolls that rotate it at a predetermined speed. The electrode is fed from an overhead reel, and the angle of inclination of the arc to seam is adjusted by the operator.

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EMPLOYMENT SERVICE BULLETIN

SERVICES AVAILABLE

A-317. Apprentice welder or welder willing to learn trade thoroughly. References furnished. 29 years of age and married.

A-318. Metallurgist: D.Sc. Over ten years' experience in industry and teaching. At present employed in teaching. Desires teaching or industrial position. Experienced in welding research. Excellent record and references. Available on short notice.

A-319. Young man with technical background, recent graduate of welding school (combination course). Experienced in machine shop and sheet metal work. Read blueprints. Also attended Brooklyn Polytechnic Institute two years. Seeks position in welding or silver soldering, offering experience and advancement.

A-320. Practical Welding Engineer experienced in all lines of gas welding, cutting, brazing and manual arc welding. Awarded second prize in Classification A1 of the James F. Lincoln Arc Welding Contest of 1938. Foreman and Supervisor of welding operations for the past five years of large motor concern in the Chicago area. 44 years of age and married. Location of position unimportant.

A-321. Welder desires position. 27 years of age, married. Three years general arc welding experience with the Rochester Transit Corporation. Has attended classes for four years in welding at the Edison Technical and Industrial High School, Rochester. Ambitious. Willing to work hard.

POSITION VACANT

V-90. Company in mid-western state requires the services of experienced man, preferably 30–35 years of age and with college training or equivalent, to take charge of X-ray department in steel and alloy plate work including supervision of all phases from taking of pictures to final interpretation. Salaried position. Give personal history, full experience and education.

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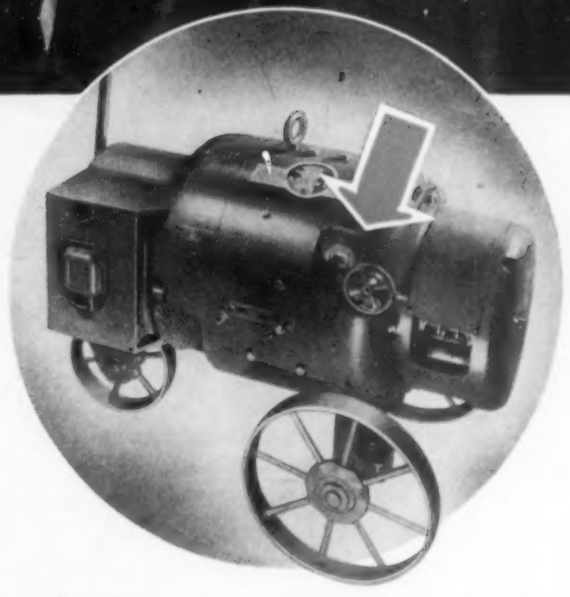

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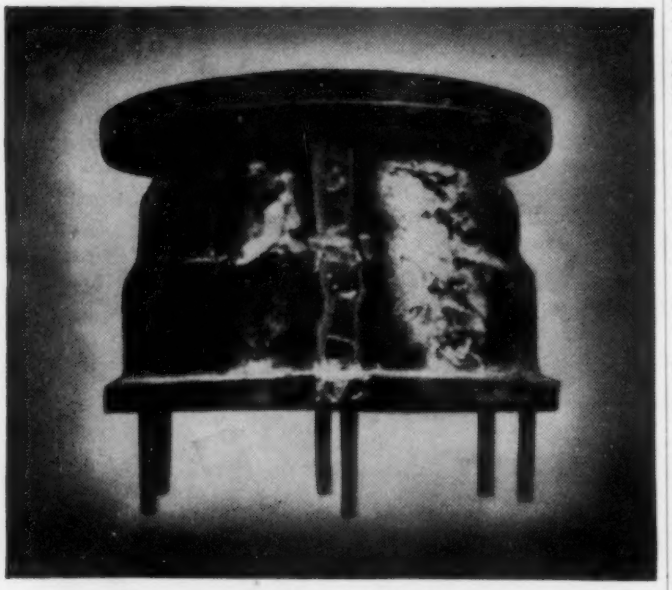

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List of New Members

June 1 to June 30, 1939

BIRMINGHAM

Fugitt, Albert T. (C), 1141—14th St. So., Birmingham, Ala.

Kunze, A. E. (B), Tenn. Coal, Iron & R.R. Co., Ensley, Ala.

Nihlen, Arvid (C), 1216—28th St. No., Birmingham, Ala.

Soyars, John M. (C), 1502½—16th Ave. So., Birmingham, Ala.

BOSTON

Anderson, Arthur R. (C), Mass. Inst. of Tech., Cambridge, Mass.

CHATTANOOGA

Grimshaw, Jr. G. E. (C), Combustion Engrg. Co., 1032 W. Main St., Chattanooga, Tenn.

CINCINNATI

Emmons, Robert H. (C), 7410 Clovernook Ave., Mt. Healthy, Ohio.

COLORADO

Gooden, Elwood O. (D), 1225—30th St., Denver, Colo.

LOS ANGELES

Layfield, Elwood B. (B), Bechtel-McCone-Parsons Corp., 601 West Fifth St., Los Angeles, Calif.

Nelson, Fred (C), 11131 Pine St., Lynwood, Calif.

Wolf, A. Francis (C), 6148 Annan Way, Los Angeles, Calif.

MILWAUKEE

Hettelsater, H. C. (B), Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis.

Hirner, F. J. (C), Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis.

Oesterlein, W. (B), Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis.

Rutishauser, M. H. (B), Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis.

NEW YORK

Armstrong, C. H. (B), Edge Moor Iron Wks., Inc., 30 Rockefeller Plaza, New York, N. Y.

Kerrigan, Joseph A. (B), 210 No. 6th St., Allentown, Pa.

NORTHERN NEW YORK

Worth, S. L. (D), 111 Mill Street, Little Valley, N. Y.

NORTHWEST

Bartter, Ivan R. (C), Lincoln Elec. Co., 222 So. 21st Ave. E., Duluth, Minn.

PUGET SOUND

Flint, Wm. M. (B), Olympic Steel Wks., 151 Horton St., Seattle, Washington.

Nelson, J. T. (C), Air Reduction Sales Co., 3623 E. Marginal Way, Seattle, Washington.

Tadlock, J. H. (B), J. E. Haseltine & Co., 440 Holgate St., Seattle, Washington.

ST. LOUIS

Coleman, Hazen (C), Spiller Apts., Herrin, Ill.

Lindsey, Laverne (C), 209 E. Pine, Herrin, Ill.

Misker, Francis (C), 706 South 21st Street, Mt. Vernon, Ill.

SOUTH TEXAS

Carver, John A. (D), 3012 Morrison St., Houston, Texas.

WASHINGTON, D. C.

Piltch, A. (C), 1445 Otis Place N.W., Washington, D. C.

NOT IN SECTIONS

Guedeman, R. F. (D), Box 283, Sweet Grass, Montana.

Schramm, C. H. (B), Shaw-Box Crane & Hoist Co., Muskegon, Mich.